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ABSTRACT

This publication describes the 62 projects that received 5-year Technology Innovation Challenge Grants beginning in 1995, 1996, and 1997, with reviews of the projects occurring in late 1999 and early 2000. Part 1 of the report describes the Technology Innovation Challenge Grant (TICG) program and its importance. Part 2 contains the project descriptions, organized in four areas that illustrate the following aspects of technology's potential to impact education: (1) enhancing learning, i.e., aiding students, teachers, parents, and community members; (2) strengthening curriculum, i.e., making subject matter meaningful; (3) creating infrastructure, i.e., providing access to technology; and (4) making connections, i.e., spanning distance with technology, creating learning communities, and using World Wide Web resources. Part 3 discusses themes of TICG projects, including student learning, professional development, parents and communities, strengthening curriculum, infrastructure, connectivity, leadership administration, evaluation, sustainability, scaling up, dissemination, partnerships, and context considerations. Part 3 also presents summary observations in three key areas-evaluation, time, and context. The appendixes include a list of TCIG projects by state and a directory of U.S. Department of Education TICG staff. (MES)

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SEEDS OF INNOVATION:

THREE YEARS OF THE TECHNOLOGY INNOVATION CHALLENGE GRANT PROGRAM

Larry A. Harris

ED 472 787

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THE INSTITUTE FOR THE ADVANCEMENT OF EMERGING TECHNOLOGIES IN EDUCATION AT AEL

SEEDS OF INNOVATION: Three Years of the Technology Innovation Challenge Grant Program

Larry A. Harris

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My thanks to these individuals as well as others who played a role in developing *Seeds of Innovation*.

About the Author

Larry Harris, recently retired, was a professor and program area leader for elementary and literacy education at Virginia Tech. Since 1974, he has served in various capacities, including associate dean of the College of Teacher Education, associate dean of the Graduate School, and executive assistant to the president.

Harris taught in Minnesota public schools before earning his Ph.D. from the University of Minnesota in 1967. He was an instructor at Indiana University and the University of North Dakota before moving to Virginia Tech.

His publications include several college textbooks about the teaching of reading, research about reading instruction in a number of professional journals, and the teacher's guides for a basal reading series. He also consults widely as an evaluator for various school systems and publishing companies.

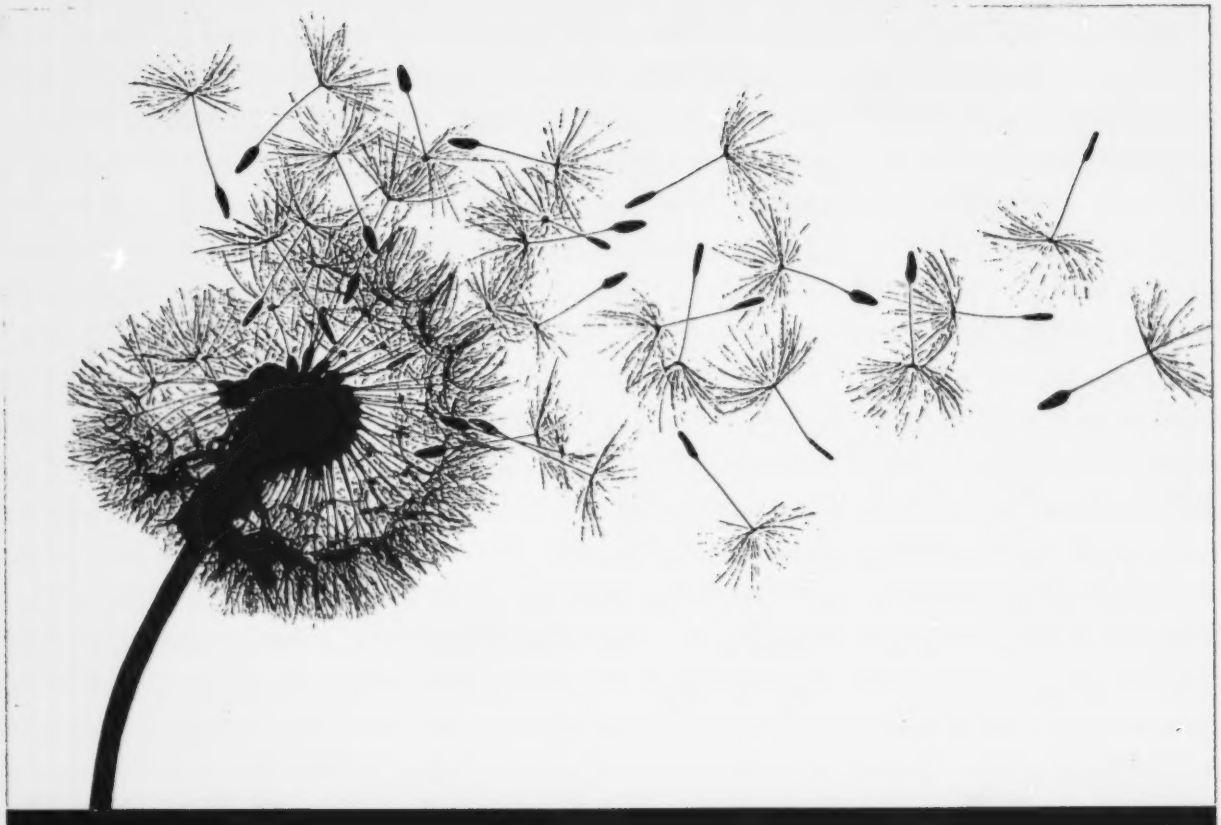
Preface

Imagine you are a classroom teacher someplace in the United States. You have just received two new iMac computers for your classroom that were purchased with funds provided by your school's very active PTO. Those new computers are going to replace three old Tandy computers given to the school 10 years ago. Although you lost one computer in the exchange, you now have a total of seven relatively up-to-date computers you can use for daily instruction. All seven are networked to each other and connected to the Internet. You are fresh from taking a course at the university on multimedia and have previously used desktop publishing software to produce a class newsletter for parents. Technology is becoming an important part of your daily teaching activities.

One morning you are in your classroom preparing for students to arrive and the principal, Ellen Blake, walks through the door. You're surprised to see her, and even more surprised when she says, "I wonder if I could persuade you to join a group that is writing a proposal to get some federal funds for integrating technology into our curriculum?"

You hear yourself say, "Yes, I'd be willing to do that." Then Ms. Blake says something interesting: "We think it would be a good idea to see how other schools around the nation have integrated technology into their curricula. Do you know of any good resources?" What would you say?

We believe this publication and its companion Web site can be such resources. They have been prepared to help educators see how some local education agencies used funds received from the Technology Innovation Challenge Grant program. This book describes the 62 projects that received five-year grants beginning in 1995, 1996, and 1997, with reviews of the projects occurring in late 1999 and early 2000. The Web site provides additional information about the program, links to project Web sites, and a searchable database of artifacts and products created by the projects. To visit the Web site, go to www.iaete.org/ticg. For summaries of the grant program and projects, simply read on.



PART 1
INTRODUCTION AND CONTEXT

The Technology Innovation Challenge Grant Program

In 1994 Congress passed Public Law 103-382, known as the Improving America's Schools Act. Section 2, Title III, Part A, known as the Technology for Education Act of 1994, created the Technology Innovation Challenge Grant (TICG) program.

The Improving America's Schools Act made a five-year commitment of $2 billion to "helping states and local communities to create and implement their own plans for integrating technology into teaching and learning for the purpose of achieving excellence among our students." (Richard W. Riley, Secretary of Education)

TICG projects demonstrate innovative applications of information and computer technologies to systemic educational reform. Projects were directed to be

- dedicated to development and demonstration
- five years in duration
- focused on reforming and improving schools
- aimed at serving all youth, with special concern for children of poverty
- designed to further the nation's economic competitiveness for participation in a global economy
- built on community partnerships with a substantial commitment of local funds
- carefully evaluated
- focused on achieving rigorous standards in the core academic subjects (reading, writing, mathematics, science, history, geography, and languages)
- designed to improve the productivity and knowledge of employees through technology

The 1995 Request for Proposals described how projects were expected to shape classroom activities:

> The information age and the education reform movement are challenging teachers to become learning coaches, managing the activities of diverse learners, learning at different rates and using a wide range of information sources. New technologies can provide teachers with the tools needed to meet this challenge in the classroom, and electronic networks can help them share their best ideas with colleagues and professionals across town or around the world. Sustained professional development for teachers to support the integration of new learning technology into the curriculum will be essential to achieving the full potential of these challenge grants.

Each Technology Innovation Challenge Grant was designed to be a demonstration program for innovations intended to produce "greater opportunities for students," "efficiency and effectiveness in education," and "very immediate and dramatic reform." The Technology for Education Act of 1994 foresaw both the need for technology literacy in the 21st century and the increasing role of the Internet as a means for crossing geographic and social barriers. With awards to each local education agency of $5–10 million over five years, TICG aimed to ensure that technology would have a far-reaching impact on improving teaching and learning.

Whatever educators learn from TICG about integrating technology into instruction must be understood to reflect the conditions that guided and otherwise constrained the program. First, all proposals were required to conform to certain guidelines. For example, they were to involve multiple partners, with a local education agency as the lead partner or fiscal agent. Federal requirements for evaluating and reporting progress were applied. These conditions (and others) may or may not have affected the nature of the projects, but they were not optional. Accordingly, the program did not constitute an open experiment in the sense that anything was possible. This is not to suggest that the constraints were intrusive or inappropriate, but to remind us that educators who received TICG funds were not free to do anything that seemed interesting. Indeed, significant departures from an original proposal had to be approved by the U.S. Department of Education.

Further, remember that TICG projects were evolving as they were being described. The most recent had not completed their five-year funding cycles. Good formative evaluation procedures triggered changes as evidence was accumulated and analyzed.

Third, we examined TICG projects using frames that focused on some aspects while downplaying others. The very complexity of the projects made complete descriptions impossible. In addition, our review was limited to the Technology Innovation Challenge Grant databases (including evaluation reports) established by the U.S. Department of Education, Interim Panel Review Reports, and project Web sites. We did not have the opportunity to visit each project or interview project personnel. Therefore, the project

descriptions in this publication should be thought of as snapshots—they capture one view of a project at one moment in time.

This overview of the 62 initial Technology Innovation Challenge Grant projects offers numerous possibilities for using technology in innovative ways to impact teaching and learning. Because the projects were designed to meet the specific needs and goals of each project consortium, the outcomes reflect the diversity of designs. The following observations—grouped into the themes of student learning, professional development, parents and communities, strengthening curriculum, infrastructure, connectivity, leadership and administration, evaluation, sustainability, scaling up, dissemination, and partnerships—are summarized in part 3 under three key considerations: evaluation, time, and context.

The Importance of the Program

The federal government makes a relatively small investment in public schools, largely because the U.S. Constitution reserves education to the states.[1] The states, in turn, delegate much responsibility to local school boards. Federal attention to education has two main areas of focus: special education and education for disadvantaged children. Activity in those two areas, primarily through the Elementary and Secondary Education Act (ESEA, Public Law 100-297) as amended by the Improving America's Schools Act of 1994 (IASA, Public Law 103-382), has been justified mainly on the grounds of protecting children who are at risk of failure. Vast differences have long existed among the states in their ability to provide help for needy children, and Congress acts to fill gaps in state and local support.

The actual dollar amount of federal support for education has never been large by comparison to local and state funding for education nor by comparison to the amount of federal money that goes to other government functions—defense, human services, public transportation, and scientific research, for example. But this does not minimize either the actual or the symbolic value of the federal dollars that *are* spent. Federal investment in education *does* make an important difference. By their actions, Congress and the executive branch provide leadership that reverberates through public and private education at all levels, preK-16.

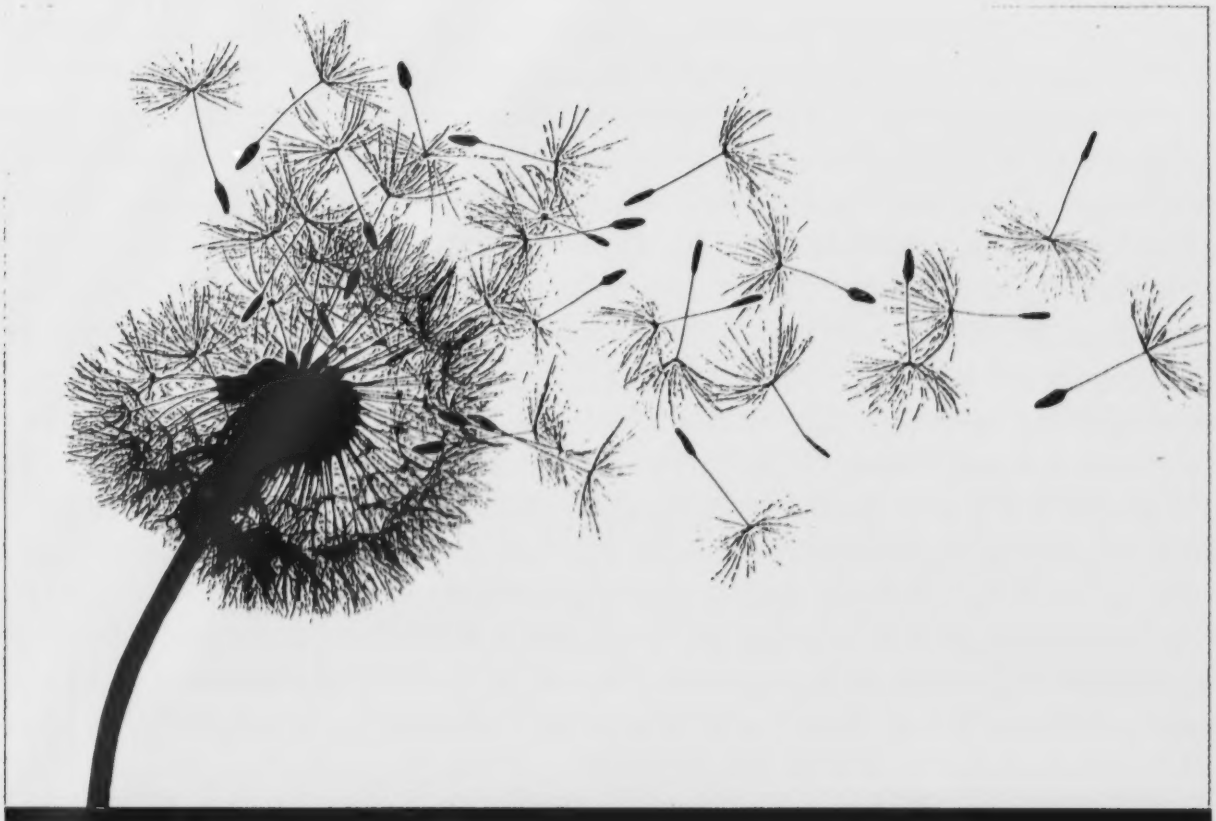
The amount of federal money that has gone into schools through the Technology Innovation Challenge Grant program is rather modest—a total of

[1] "Of the roughly $650 billion spent nationwide on education at all levels, 91 percent comes from State, local, and private sources." U.S. Department of Education, *The Federal Role in Education.* (Washington, DC: Author, 2001). Retrieved December 1, 2001, from www.ed.gov/offices/OUS/fedrole.html

approximately $400 million for 1995, 1996, and 1997 projects. But the actual amount of dollars is not the point. By appropriating this money, federal leaders made a statement about national priorities for education technologies and issued a challenge to the education and business communities, as well as to parents and taxpayers, concerning the importance of moving schools into the information age.

To understand the impact of the Technology Innovation Challenge Grant program, it is useful to contemplate where we would be if Washington had *not* taken action. Would states and local governments have recognized the need and appropriated sufficient funding to support technology infrastructures? Would local school boards and governing bodies have stepped forward? Could parent groups have raised enough money with bake sales and carnivals for equipment, wiring, professional development, and all else related to moving school technologies into the 21st century? Would business and industry have acted to help schools produce graduates who have the skills to work in a high-tech world? Would teachers and administrators have felt as challenged to integrate technology into instruction and into the curriculum?

The answers to these questions are unknown, of course, because Washington *did* act, but simple deductive reasoning suggests TICG made an important difference. Federal government raised awareness and provided seed money ($51 million in the first three years) that attracted significant additional investment in education technology. TICG has not satisfied the need, but it has funded projects that lead the way for more schools to respond to the challenge.



PART 2
PROJECT DESCRIPTIONS

This section looks at how Technology Innovation Challenge Grant projects addressed various issues of teaching and learning.

In their writing about one project, Barbara Means and Shari Golan captured the essence of what many educators hoped would result from TICG-funded integration of technology:

> It was hypothesized that the introduction of student-centered multimedia projects and technology supports into the classroom would influence classroom interactions in fundamental ways, encouraging longer-term, more complex assignments; more coaching and less lecturing on the part of teachers; increased collaboration and peer teaching; and greater involvement with external resources. These changes in classroom activities, in turn, were expected to have desired effects on students such as increased engagement, motivation, and self-esteem; creation of more complex high quality work; collaboration skills; technology skills; and deeper understanding of content.[2]

Indeed, many TICG projects do demonstrate how technology can transform a classroom by supporting learning in ways that allow learners to be active, to work with other learners, and to build on innate curiosity. This inspires some advocates to say that the use of education technology will cause changes in the basic nature of schooling—an ambitious claim. They believe technology can transform what David Tyack and William Tobin call the basic grammar of a classroom, thereby altering the role of the teacher, changing the nature of the learning activities, and empowering the learner.[3]

Thinking about how humans learn can help to frame our look at the projects and shape our assessment of their success and value. Some educators conceive learning as a constructive activity in which a learner, typically in collaboration with others, comes to understand the world through his or her own interpretation. Others conceive learning as knowledge acquisition and assume we want children to learn a specific set of facts. Many excellent discussions of learning theory are available for those who want to explore the topic.[4]

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[2]B. Means and S. Golan. *Transforming Teaching and Learning with Multimedia Technology.* (Menlo Park: SRI International, 1998). Available at http://pblmm.k12.ca.us/News/Challenge2K.pdf

[3]D. Tyack and W. Tobin. The Grammar of Schooling: Why Has It Been So Hard to Change? *American Educational Research Journal,* 31(3): 453-79 (1994).

[4]The subject of how children learn is the object of much research and debate. Respected summaries of the research include the *Handbook of Research on Teaching* (American Educational Research Association, 2001, available at www.aera.net/products/handbooks/tableofcontents.htm); the *Handbook of Educational Psychology* (MacMillan Library Reference, 1996, sponsored by the Division of Educational Psychology of the American Psychological Association), and the *Handbook of Research for Educational Communications and Technology* (Association for Educational Communications and Technology, updated version of 1996 edition available at www.aect.org/Intranet/Publications/edtech/index.html

Whichever approach to learning a project embraced, its participants found a variety of ways in which technology could assist with changing the teaching/learning experience. Many of these are outlined and summarized in part 3.

It is not uncommon for education technology to be described as another classroom tool, and people often speak of computers as tools. That is to say, like a hammer that allows a carpenter to pound a nail, a computer assists the user in accomplishing a task.

Unfortunately, some uses of technology tools fail to take full advantage of the unique capabilities they offer. Stories abound in which computers are used in lieu of workbooks or paper-and-pencil tests. By way of illustration, one popular reading program uses computers to test whether children can answer five multiple-choice questions about a book they have read. That is the full extent of computer use. The book is not accessed via computer, nor is software used to expand or extend a child's understanding of the story's topics. In that particular reading program, the computer is simply an expensive way to determine which children will receive credit for having successfully "read" the book.

The Technology Innovation Challenge Grant projects described in this publication demonstrate higher levels of technology use. These range from the fairly simple, such as teachers and students using the Internet for research, to the more complex, such as teachers and mentors collaborating online to review student work that was presented online.

TICG projects are presented here so as to illustrate four aspects of technology's potential to impact education:

- *enhancing learning:* aiding students, teachers, parents, and community members
- *strengthening curriculum:* making subject matter meaningful
- *creating infrastructure:* providing access to technology
- *making connections:* spanning distance with technology, creating learning communities, and using Web resources

The following matrix presents 19 of the 62 Technology Innovation Challenge Grants and their respective frames of emphasis. Each frame examines Challenge Grant projects from a particular perspective, focusing attention on certain educational interests. While projects have been described in terms of the specific frame, each Technology Innovation Challenge Grant encompasses additional frames. The narrative that follows illustrates in greater detail each of the 19 projects as they relate to the four frames. Descriptions of the remaining 43 projects, also presented in relation to the selected frames, provide additional examples of innovative uses of technology in education. More information can be found on both the 19 featured projects and the remaining 43 projects by visiting the Web sites (accessible through www.iaete.org/ticg) or by contacting the project director (listed in the Appendix A).

	Enhancing Learning			Strengthening Curriculum	Creating Infrastructure	Making Connections		
	Student	Teacher	Parents and Community			Spanning Distance	Creating Learning Communities	Using Web Resources
American Gateways, NY		x						
Anderson Community Technology Now (A.C.T. Now!), IN			x					
Aurora Project, OK				x				
Career Connection to Teaching with Technology (CCTT), FL				x				
Cascade Consortium, WA						x		
Generation WHY, WA		x						
Kansas Collaborative Research Network (KanCRN), KS	x							
The Louisiana Challenge, LA					x			
NatureShift! Linking Learning to Life, ND								x
New Spectrum Learning Program (NSLP), CA							x	
Project LemonLINK: The Connected Learning Community, CA							x	
Project WhistleStop, MO								x
Richland Clicks!, SC					x			
Schools for Thought, TN				x				
Silicon Valley Challenge 2000 Multimedia Project (PBL+MM), CA	x							
State of Utah Resource Web (SURWEB), UT								x
Teacher Led Technology Challenge (TLTC), CA		x						
The Virtual High School, MA						x		
WEB Project. Creating a Web of Evidence of Student Performance, VT							x	

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Enhancing Learning

Every TICG project addressed learning, even one that focused primarily on providing access to digital images on the World Wide Web. This section describes those projects that featured particularly interesting uses of technologies to support learning by students, teachers, and parents and members of the community at large.

Enhancing Learning: Students

Silicon Valley Challenge 2000 Multimedia Project (PBL+MM), 1995

San Mateo County Office of Education, CA
http://pblmm.k12.ca.us

This project set out to incorporate an exemplary model of project-based learning supported by multimedia into the classroom (hence the PBL+MM part of the project title). The underlying assumption was that students acquire knowledge, the means to express it, and presentation skills by participating in collaborative efforts to address real-world problems. Technology would help students find and analyze relevant information and make multimedia presentations of their findings.

Located in Silicon Valley, PBL+MM is one part of a larger effort known as Challenge 2000. Challenge 2000 grew out of the early 1990s Joint Venture Silicon Valley Network, a group of education, business, and civic leaders who wanted to develop a regional strategy for improving the area's economy and quality of life. The network's multifaceted vision produced a number of initiatives, with this being one of its efforts at improving education.

The Web site describes PBL+MM as devoted to "building best practices in project-based learning with multimedia." Implementation in K-12 classrooms followed three main paths: (1) working with children, (2) integrating curriculum and professional development, and (3) working with teachers.

The first path "harnesses the power of multimedia" to help students complete research projects and report the results using sophisticated presentation software. The intent was that, through communication, planning, and problem solving, San Mateo students would learn content and skills as they moved through the various stages of inquiry. Because they

Examples of San Mateo Project-Based Learning Topics

Students and teachers together identified real-world problems with potential to produce authentic learning activities. Making Improvements in Our School Food Program encouraged sixth-graders to explore their school environment. Another project pursued answers to the question "How did Native and African Americans and women of the United States achieve equal rights in a society that challenged their integrity and perseverance?" In Did Newton Get It Right?, eighth-graders developed a digital movie on Newton's laws of motion for fifth-graders.

Teachers described the results of several student inquiries on the Web site (http://pblmm.k12.ca.us/index.html). These showed how students collaborated to gather information through activities ranging from consulting business leaders in the local community to using Inspiration software to brainstorm possible solutions and using the Internet to search for relevant information. Products to describe, analyze, and summarize what students learned were prepared using multimedia tools.

The following description of a final product is taken directly from the Web site:

> In this movie and HyperStudio stack, seventh grade students from the classes of Gail Carcione, Jeff Hanck, and Marilyn Wallenstein at Central Middle School designed a research facility suited to working and living in the extremes of Antarctica. The excessive low temperature of the environment was considered as the students, constrained by size and budget, designed the research station. The project was presented as though the students were representing the design company and making a sales pitch to the research scientists that needed the facility. HyperStudio stacks were used for the presentations. Going far beyond the original assignment, these students also created a virtual walkthrough of the first floor of the facility.

typically conducted research in groups, students learned how to collaborate and cooperate as members of a team, skills the working world values highly. At the final step in the inquiry process, students displayed their work at project-sponsored multimedia fairs. Teachers assisted by acting as coaches—depending on the age and previous experiences of the learners, teachers initiated discussion of issues, helped in arriving at statements of the problems, observed, asked clarifying questions, offered suggestions, and provided feedback.

In the second path, teachers learned to transform traditional curriculum content into a project-based approach and to think differently about how to support student learning.

The third path followed professional development activities of the Joint Venture's 21st Century Education Initiative, which established the Professional Development and Dissemination Network to promote exploration, implementation, and dissemination of best practices. One of these is the use of five innovative preservice and in-service projects focused on measuring and analyzing student accomplishments, arranging a series of meetings where teachers themselves create a way to share their ideas. Another attempts to slow teacher turnover by designing and implementing new models for preparing and supporting teachers. (Readers may explore these efforts on the project Web site.)

PBL+MM teachers had an extraordinary opportunity to work together in planning and implementing a project-based approach to curriculum and learning. In peer "learning communities" experienced teachers mentored and assisted their colleagues through such activities as workshops and jointly developing minigrant proposals for equipment and supplies. Much of the professional development program employed Internet-supported communication, including consultation via e-mail.

All TICG projects involved partnerships, but the Silicon Valley project was extraordinary in that regard, perhaps because so many high-tech firms

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have homes in the region. The San Mateo Challenge 2000 Multimedia Project involved a consortium of schools and school systems and nearly 40 local and national foundations and business partners, including many leading technology corporations.

Many Technology Innovation Challenge Grant projects have received awards for innovative uses of technology and for leadership. None has received more recognition than this one. In September 2000, the project was selected by the U.S. Department of Education's Educational Technology Expert Panel as one of only two "exemplary" programs in the nation. The four criteria were (1) quality of program, (2) educational significance, (3) evidence of effectiveness, and (4) usefulness to others. (To read more about the two exemplary and five promising programs, see the panel selections at www.ed.gov/offices/OERI/ORAD/LTD/panel.html.) The project was also included in the Honors Program of *Computerworld* magazine.

The Lens Influences What We See

Like most TICG projects, the San Mateo project was multifaceted. There is bound to be some distortion that results from examining only a particular aspect (such as the impressive array of partnerships), separating it from the whole as though that component alone made the program noteworthy. Challenge 2000 was about much more than partnerships or inquiry learning. In fact, the project had a strong professional development program and used Web resources very effectively, so could have been presented in one of the other frames. The alternative to focusing on one component would be presenting full descriptions of each project, an approach that would produce a long, cumbersome, and poorly focused publication. The same kind of reporting that is done here about the San Mateo project applies to every other project description in this publication. Certain aspects have been highlighted for the purpose of illustrating particular points.

Contact information for each project (including the URL for the project Web site, where available) is provided so that readers can pursue further details.

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The Kansas Collaborative Research Network (KanCRN) offers an interesting contrast to the San Mateo project with respect to approaches to student learning. Two aspects of inquiry learning have to do with who asks the question students will answer and whether more than one answer is possible. San Mateo chose a student-directed approach—the question about how an Antarctic research station could be built was developed with student involvement. In KanCRN, inquiries began with questions posed by teachers and followed prescribed steps for arriving at solutions. Students were active in both projects, but KanCRN emphasized having students "do science" rather than watch someone else do it, read about it, or hear someone talk about it. Using standard lab procedures, students gained experience in gathering and recording data as well as analyzing the data and drawing conclusions.

Kansas Collaborative Research Network (KanCRN), 1997

Kansas City Public Schools, KS
http://kancrn.org

KanCRN addressed national efforts to reform science and technology education through curriculum. National and state standards—such as the National Science Education Standards, the Benchmarks for Science Literacy, and Kansas Science Education Standards—played a very important role in the project. This description from the project Web site conveys the essence of the enterprise:

> The Kansas Collaborative Research Network is a community of researchers, teachers, and students interested in conducting collaborative research. Developed originally by The Kansas City (KS) Public Schools, The Olathe School District, and The University of Kansas, this community is working together to create an instructional model that demonstrates that doing science is a better way of learning science. The community of KanCRN seeks to expand to nationwide participation and is committed to promoting the processes of scientific research among students and amateur scientists.

KanCRN engaged students in hands-on learning activities focused mainly on science. The main learning strategy was experimentation conducted by groups of students who followed clear, step-by-step instructions. Recent activities included studies of ground-level ozone, ultraviolet radiation and yeast, amphibians as indicators of changes in the world's ecosystem, stream monitoring, natural dyes and stain removal, and systems modeling. Much of the data collection was completed by groups of students following detailed instructions provided on the KanCRN Web site. Students

gathered and reported their results via the Web site, where access to the data collected by all other students on the same experiment was available to everyone for analysis and comparison. Students also conducted guided research in social studies and math, on topics ranging from African American immigration to insect and bird migrations. As with most project-based learning activities, students presented the results of their research at an annual conference.

An important program component was the online collaborative research network, with its threaded discussion areas, organizing protocols, interactive databases for data submission and retrieval, background information on the research areas, and publication area for students to submit their work. This technology linkage between students and experts in various areas of science contributed a great deal to the learning. Students, especially advanced students who had gone beyond the structured experiments, used technology to engage in regular dialogue with experts in other locations.

Over time students learned to apply these methods to original experiments so they could pursue other lines of research and interact online with mentors who provided feedback and suggestions.

KanCRN attended to teacher professional development by immersing teachers in a research environment. This strategy supported others—short technology skill sessions, project development, yearlong project development classes, presentations, and involvement of teachers and students in common sessions to acquire new skills and knowledge. All activities focused on three areas: technology skills, science content knowledge, and pedagogy. More than 1,500 teachers have participated in activities.

The KanCRN network has grown steadily since October 1997. By May 2001, 727 classrooms from 506 schools in 46 states and 13 countries were registered members of the research community.

Teacher-student interaction was frequent, and classrooms were arranged to facilitate interaction. Among other findings:

- KanCRN teaching and learning strategies were successfully implemented in the classrooms
- students had good access to technology in their classrooms and their schools' computer labs/media centers
- student use of technology varied in frequency according to their purposes
- teachers believed the most effective uses for technology demonstrated the value of Project KanCRN for teaching and learning

One important lesson identified by KanCRN staff was that adoption of the research-based model central to the project depended greatly on the school principal. Early efforts by staff to work teacher by teacher were less

effective than working through the principal. They noted that principals have the ability to encourage adoption of the approach and to smooth the logistical problems of scheduling times for KanCRN staff to meet with teachers as they integrate technology into their curricula.

The KanCRN project proclaims itself "open to anyone with an Internet connection and an interest in research." Educators may register at the Web site to become active members of the community.

Other Projects: Student Inquiry

Four Directions, 1995
Pueblo of Laguna Department of Education, NM
www.4directions.org

This project focused on changing classroom learning environments through integrating Native American culture into the curriculum. A consortium of 19 Native American schools in 10 states was created to assist Native schools form a community of learners. Technology provided communication links among the consortium members. Four Directions helped schools plan and install Local Area Networks (LANs) connected to the Internet, integrate technology into the classroom, and develop a database of educational resources for and about Native educators. Student inquiry was used to shift classrooms from being teacher directed and focused on isolated skills to being student-centered. Strong involvement of parents and tribal elders helped students explore and conduct research. All personnel worked together to create a demonstration project with the National Museum of the American Indian. Participants from Michigan's Nah Tah Wahsh School and New Mexico's Santa Clara Day School created a virtual museum tour using QuickTime Virtual Reality.

New Technology, New Knowledge, New Work (New3), 1995
Summit County Educational Service Center, OH

The Summit County project set out to change the basic instructional paradigm in the classroom from "one of fragmented skill-based tasks to having children do inquiry into the questions they have about their place in the world and what it means to be a citizen in a democratic society." To achieve this shift, the initial focus was on professional development designed to help teachers examine their personal beliefs about teaching and learning. This would be a challenging task for a single school and was even more challenging when 106 schools in 18 districts were involved.

Technology support helped in several ways. First, access to multimedia computers was provided in every classroom. Second, every classroom was connected to the Internet. Third, the professional development program

included technology training and support. Fourth, software and online learning resources became an integral part of every school's curriculum.

Triton Project, 1995
San Diego Unified School District, CA
http://projects.edtech.sandi.net

When teachers combine new technologies and new instructional methods, student learning should be impacted. Through extensive professional development, teachers in Triton Project schools learned to develop WebQuests, guided inquiries conducted over the Internet and based on a model created by Dr. Bernie Dodge of San Diego State University. In its first year Triton focused on creating WebQuests with the ocean as a common theme and prepared projects for students at all grade levels. In a later effort to align WebQuests with the curriculum, teachers developed investigations based on standards for their grade levels and subject areas. Additional quests proposed challenges as varied as creating an electronic time capsule that would show how this student generation would be remembered to defending a position statement on whether the United States should convert to the metric system of measurement. The Triton Web site includes a database of teacher-created projects with assessment rubrics and currently gets 90,000 hits a month, half of which come from outside San Diego.

The Trails Project, 1996
The School District of Kansas City, MO

Teachers and administrators representing 58 schools in 15 districts from isolated rural areas, small towns, and urban areas located near the Santa Fe and Oregon Trails attended weeklong symposiums to receive intense technology training. At meeting sites near the trails, teachers from Colorado, Idaho, Kansas, Missouri, Nebraska, New Mexico, and Wyoming learned about the historic pathways and how to integrate technology into the curriculum to transform classrooms into student-centered learning environments.

This consortium of school districts was supported by partnerships with the Bureau of Land Management, the National Park Service, historical groups, museums, and experts on the trails. Partners contributed artifacts and materials and sometimes helped with the "ask the expert" area of the project Web site.

New technology helped students use e-mail for correspondence, create their own Web pages, and make multimedia presentations. Project-based learning strategies that encouraged problem solving, collaboration among students, content mastery, and exploratory learning resulted in a changed classroom culture.

Education for a Sustainable Future (ESF), 1997
Cobb County School District, GA
http://csf.concord.org/esf

Since the beginning of Education for a Sustainable Future, teachers have approached instruction differently to make it more interdisciplinary, collaborative, student focused, inquiry oriented, and technology rich.

Students were asked to study environmental, economic, and social systems that must be sustained to ensure our future. The unit assignments were intended to engage students through using an array of standard technologies, both hardware and software. In addition, the Center for Highly Interactive Computing in Education and the University of Michigan developed a suite of three software programs for ESF. The programs, *Mind-it, What-if Builder,* and *Community Planner* were placed on the Web site.

Reality Based Learning Project (RBL), 1996
Kirby School District #140, IL
www.d348.wabash.k12.il.us/rbl/main.htm

A seventh-grade class raised local awareness of the United Way by preparing a community awareness campaign. Products included tray liners for Taco Bell, magnets, fliers, and a Web page. This is one example of how students were a part of the Reality Based Learning (RBL) project, which used an instructional variation on problem-based learning. RBL fused connections between the community and the schools, making schools more visible and community members more involved. Mutually beneficial partnerships created better communication and greater awareness of school programs in general. Students got a strong dose of reality through preparing actual products to address community problems.

Nine diverse Illinois communities collaborated with research partners Argonne National Laboratory, the Illinois State Board of Education, Northwestern University, and Western Illinois University. These partnerships supported learning; students learned problem solving in real-world situations and teachers became coaches and learning facilitators in the classrooms.

Seattle Community of Learners System (SCOLS), 1996
Seattle Public Schools, WA

Students, teachers, and community members all benefited from the Seattle Community of Learners System. Calls for school reform caused the district to initiate restructuring efforts that fully integrated technology and school-to-work concepts into a standards-based K-12 curriculum. SCOLS developed a four-year information technology career pathway that includes nine technology courses for high school students. This career course pro-

vided students with opportunities to learn skills and knowledge employers want.

Professional development for SCOLS included training core teachers in applied learning using technology. The 30 hours of course work stressed learning a common vocabulary and included developing projects for each teacher's classroom. Approximately 400 teachers received training, well beyond the original goal of 95.

To extend the impact into the community, SCOLS aimed to reach low-income public housing residents who needed support in order to use technology. Plans to develop transferable models that target underserved children and their families were hampered by the inability to find facilitators in the targeted housing projects. Despite that difficulty, more than 1,000 adults participated in programs at the Community Learning Centers.

Technology and Learning Collaborative (TLC), 1995
Waukegan Community Unit School District 60, IL
www.ed.gov/Technology/Challenge/ProjectDesc/pt6.html

Faced with many struggles familiar to educators in urban centers, the Teaching and Learning Collaborative thought significant changes in classroom procedures could improve student achievement in math and science. Using education technologies and collaborative learning units, students faced real-world problems and issues. Authentic tasks with authentic assessments helped students become more engaged in their learning. Different expectations moved students from the role of passive listener to the new roles of collaborator and, sometimes, expert. In What You Can't See CAN Hurt You: An Engaged Unit on Human Pathogens and Their Inactivation, one teacher had students practice real problem-solving techniques. The activity presented this scenario: A deadly virus hits a small, remote African village. Students, working in teams, must ensure the safety of the population. Students prepared a plan to help and comfort citizens stricken with the virus, and advised the residents on how to avoid contracting the disease.

To make TLC sustainable beyond the initial funding cycle, a train-the-trainer model was used for professional development and to foster leadership. Summer institutes conducted through the Baxter Allegiance Foundation and Barat College allowed teachers to work with research scientists on finding resources and technologies to use in their classes while expanding their knowledge base.

Not only did students learn new approaches to information gathering, members of the community could take advantage of high-speed Internet access in centers open to everyone. The TLC project used *Captured Wisdom on Adult Literacy*, a video by the North Central Regional Technology in Education Consortium, in its interviews with student and teachers to help disseminate intentions of the project to the Waukegan community.

Let's return to the tool metaphor for a moment. Many tools are versatile enough to be used in a variety of ways. This is certainly true of computers. In fact, a computer is not so much like a hammer as it is like an entire toolbox. A skilled carpenter knows how to use all the tools in a toolbox, much as a teacher understands (or needs to understand) computers so that she can use them in a variety of ways. The greatest challenge to integrating technology into education may be providing assistance that enables teachers to take full advantage of their new tools.

And, although the TICG projects illustrate that change is possible, the cause of the change is not the use of technology, it is the beliefs of teachers. When teachers decide to alter the approach to instruction, technology supports them in making the desired changes. Such changes most often occur when teachers have an opportunity to reflect on their teaching, something that takes time.

Enhancing Learning: Teachers

Teachers who commit to improving student learning may readily see the value of education technology, but they need more than a positive attitude. First, teachers need to feel comfortable with technology, to gain the confidence that comes only from knowing how to use it. Second, teachers need support as they begin to use technology in instruction, and this may involve changing long-held notions about how to fulfill their role.

Teachers are no different from other learners; they like to see new skills demonstrated by someone who is competent and then experiment themselves. This works best if someone experienced provides instruction, support, and encouragement.

School systems face a significant challenge in educating a generation of teachers who entered the profession prior to the widespread availability of computer technology in schools. Many states require newly certified teachers to meet state technology standards. Veteran teachers also must provide evidence that they are competent with technology. The International Society for Technology in Education (ISTE) has a standards project called the National Technology Standards (www.iste.org/standards). In addition, a federal grant program called Preparing Tomorrow's Teachers to Use Technology (PT3) assists many teacher preparation programs in adding technology training to their curricula (www.pt3.org).

TICG projects have used a variety of professional development models, with most falling in one of the following categories.

- *Teachers teaching teachers* employs teachers who have reached the expert level to help novices learn to use technology, a practice known as peer mentoring.
- *Expert student programs* train students to become competent enough to teach teachers to use technology.
- *Outside experts* from colleges, universities, or businesses may provide technology instruction, often using online courses.

Millions of teachers have faced the challenge of becoming computer literate in recent years. Many have done so in a predictable way: They find a teacher who has gained some level of expertise and ask that teacher to share the knowledge. This approach seems so natural it might not even occur to us to do it any other way. Teachers who know something about computers and how to integrate their use into instruction are the logical choices to provide instruction and encouragement.

This quote from the Berkeley TICG Web site reveals a commitment to making teachers the key change agents in the use of technology for instruction:

> As Education Secretary Richard Riley has pointed out, "teachers are still at the heart of instruction." And, as Larry Cuban has also correctly pointed out (*Electronic Learning*, May/June 1995), the way schools are currently organized, (and the way they are likely to remain organized over the next decade) makes the classroom teacher the "sole gatekeeper of new technology."

Educators in Berkeley didn't invent this approach, but they effectively employed it in their Teacher Led Technology Challenge (TLTC). The colleague-to-colleague model has enormous appeal to teachers and to leaders of various school reform networks (Philip Schlechty, John Goodlad, Thomas Sergiovanni, and Ernest Boyer are educators whose work in this area has been exemplary) and experts on reform and change in education (Michael Fullan and Seymour Sarason being two of the most obvious examples). Reform that starts at the classroom level and flows upward through a school system has a reasonable chance of succeeding—and sticking. The Berkeley approach builds on the teacher-as-leader concept, which posits that what classroom teachers do to transform their teaching (with or without technology as the tool) is usually more effective if the impetus comes from teachers themselves.

Teacher Led Technology Challenge (TLTC), 1996

Berkeley Unified School District, CA
http://tltc.berkeley.k12.ca.us

The following explanation from the Web site clearly and concisely outlined the project goals:

1. Classroom teachers will learn how to use technology to:
   a. accommodate a greater range of learning styles,
   b. help all students master the core skills emphasized in our curriculum, and
   c. structure classroom experiences that involve cooperative learning, cross-age tutoring, increased student initiative and higher order thinking;
2. Students will use available technology tools to gain a deeper understanding of the subjects they study and greater confidence in their own learning abilities, and to demonstrate higher levels of attainment in core basic skill areas;
3. Parents and other family members will learn how to promote enjoyable, classroom-relevant instructional experiences around a computer in the home.

The TLTC project started in only a few schools and gradually expanded to all 15 elementary and middle schools in the district. The program did not operate in libraries, labs, or media centers, but in regular classrooms. The project expressed a commitment to the idea that technology could be especially helpful with learners who might not otherwise experience much success in school.

The Berkeley project was characterized by several key elements:

- Peer-to-peer support was at the heart of the program.
- Change in teacher use of technology would happen incrementally through a three-stage implementation process.
- Teacher choice was respected—teachers could join the project when it was "right" for them and set their own pace in using technology for instruction.
- Multimedia computers and multimedia software were placed in every classroom.
- Technology was used to engage learners in cooperative group activities, project-based learning, and other learning opportunities.

- Building leadership was provided by teachers chosen to act as technology leaders and mentors, with roles rotating to new teachers each year.
- A full-time technician, supervised by the lead teacher, provided hardware, software, and network support for classroom teachers as they integrated technology into instruction.
- Workshops, in-class demonstrations, and mentoring were provided.
- An extensive array of optional staff development activities was offered.
- Substitute teachers were hired so classroom teachers could attend conferences and visit classrooms where teachers used technology effectively.
- Computers and software were sent into the homes of the neediest children as part of the TechnoKid program.

A key element in the Berkeley professional development program was the concept of the lead teacher. For a period of one year a teacher in each school was the designated technology leader. The role was not as much about teaching computer proficiency as it was about inspiring, motivating, and guiding other teachers as they pursued using technology to support instruction.

In addition to the lead teacher in each school, the Berkeley project offered an impressive array of other support services. For example, Prep Shops brought Classroom Technology Integration (CTI) specialists into schools to work with small groups of teachers to plan and prepare computer-related learning experiences for their classrooms. During follow-up visits, specialists helped the teachers implement the activities. The Classroom Technology Integration Resource Center offered opportunities for grade-level colleagues to share ideas, examine materials, and develop their technology integration skills.

Titles of other activities included Resident Expert Workshops, Quick Shops, Lead Teachers' Workshops, Principals' Menu Workshops, School-based Technology and Troubleshooting Workshops, Occasional Technology Expos, Technology Skill Sessions, and Observations. Services included vendor-provided training sessions, full-time summer workshops (for credit), and visits to exemplary CTI schools.

The Berkeley professional development program built an extensive support system around the philosophy that teachers make the difference in a classroom, whether the issue is improving student achievement or making more effective and more extensive use of technology.

The overall results of the Berkeley project have been excellent. The strategy of starting in a few schools and working with teachers who wanted

to be involved was effective. The expansion of the program into other schools and other classrooms supported a belief that "gradualism" can work. Teacher attitudes toward technology grew more positive as their ability to handle the technical aspects improved. Teachers integrated technology voluntarily and effectively, students benefited, and the emphasis on student learning kept the means and ends from getting confused. Disadvantaged students in particular seemed to show special gains in basic skills. Altering the teaching paradigm, changing the curriculum, and integrating technology created synergy—but it took time.

Compaq gave TLTC a Teacher Development Grants Program Award in 1997-98 in recognition of its creativity, dedication, and resourcefulness in helping to build a technology-literate teacher workforce.

Generation WHY, 1996

Olympia School District, WA

www.genyes.org

This professional development program offers an interesting contrast to the program in Berkeley. One obvious difference is that students rather than teachers assume the role of technology "experts." Another difference is that Generation WHY (Genwww.Y) has spread well beyond Olympia, gaining substantial national recognition, while the Berkeley project stayed primarily in the home school district.

The Generation WHY Web site describes "the extensive involvement of students as collaborative partners with their teachers, their school district and the local community" as a main focus. However, the project developed the skills of both students and teachers. As teachers received help to develop curriculum, they also learned computer proficiency. Students learned, and had a chance to practice, both technology and leadership skills as they collaborated with teachers to create and deliver lesson and unit plans.

Students in grades 6-12 could gain competency with technology by completing an 18-week course in which they conducted research; wrote extensively; presented their findings using multimedia; and developed mentoring, project development, and leadership skills. (The program added students in grades 4 and 5 in subsequent years.) The course content included eight units on such technology aspects as the use of e-mail, listservs, and other online communication and research tools. Various multimedia software packages were taught for authoring and presenting research findings. Units on collaborating with teachers included lesson planning, incorporating state and local academic standards into classroom activities, planning a research project, and writing up the results. Student

and teacher working together produced a curriculum project for the teacher to use with students and for the Genwww.Y student to turn in as a class project. Hundreds of complete projects were posted on the Web site (recently recognized as the most outstanding curriculum-based Web site in the United States by *Curriculum Administrator* magazine). Every Genwww.Y project was aligned with state and local education standards. Projects routinely included assessment strategies and indicators both for the Genwww.Y student and the partner teacher, as well as students in the teacher's class.

For example, one student developed a video presentation showing historically significant sites such as terraces, electrical towers, grain elevators, historical buildings, oil rigs, and windmills in Graham County. The Genwww.Y student and eighth-grade social studies teacher used a digital video camera, color scanner, computer, video-editing software, photo-editing software, and Internet resources. The video incorporated digital images and sound into an instructional resource for a classroom history unit. The teacher-student partnership prepared a test to assess what students learned from the videotape, and the student also gathered assessment information through a teacher interview and an online survey form.

The projects produced by the teacher-student collaborations were used primarily at the middle school level (grades 7 and 8), but some involved high school classes. The greatest recent growth in the project occurred at the elementary school level.

Genwww.Y students—the technology "experts"—have attended national conferences to present information about the program. The International Society for Technology in Education (ISTE) published the Generation WHY curriculum and disseminated the program on video and CD-ROM. Royalties earned from these materials support the continuation of the program. Neighboring teacher education colleges have introduced preservice teachers to the program, and teacher education programs in four other states have incorporated the concepts into their curricula.

Partners included the state departments of education in Washington, Kansas, Alabama, and the Virgin Islands, and the board of education in New York City. Other school districts directly involved in supporting the project include the Madison school district in Wisconsin; Centralia, Pioneer, and Shelton school districts in Washington, and Broward County school district in Florida. Corporate sponsors include Microsoft Corporation, Data Watch, Xerox Corporation, JDL Technologies, Intel Corporation, Apple Computer Inc., the Milken Family Foundation, and AT&T Cable. The Evergreen State College and St. Martins College in Washington also are partners in the project.

Before launching Generation WHY, the project director spent five years building Olympia's student technology program. Students began the

18-week course by developing information and technology literacy. An appropriate project was identified and a teacher-student team created. The course was designed to help make better use of existing technology infrastructure and did not require upgrading to any particular configuration of equipment. The goal of the program was to adapt instruction to the technology in place. The director recently created an external organization known as Generation Yes to respond to the growing interest in Genwww.Y materials and procedures.

(Find out more at http://genyes.org/genwwwy/description.php.)

Generation WHY has served more than 8,000 students, trained more than 8,400 teachers, and involved more than 250 school administrators. Students and teachers who have participated in the project reported very positive outcomes.

- Students accumulated substantial experience and skill in the areas of computing, network use, communication, collaboration, and project management.
- Students and partner teachers completed and implemented more than 1,000 curriculum projects in many content areas. These projects were often reused and refined by the partner teachers as they updated their curriculum and lesson plans.
- Students and teachers demonstrated positive attitudes about the curriculum projects, and about the collaborative, cross-age teamwork experience. Partner teachers reported virtually no negative experiences; they reported positive effects on their comfort levels with personal and teaching-related use of computers, attitudes toward educational computing, and interest in learning more about education technology.
- Both students and teachers reported interest and behavioral intentions to continue developing collaborative projects that use computing and telecommunications resources for curriculum improvement and for other community service efforts.

Genwww.Y activities reached out beyond local schools. They included working with preservice teachers to staff after-school or community-based computer labs and helping other students, family members, and community members learn more about computing. Genwww.Y graduates have helped preservice teachers who are taking classes on educational technology. Partnerships have been established with teacher education institutions, most notably The Evergreen State College located in Olympia. Graduates of the program have participated in other opportunities for student leadership and community service, many of which promote structural changes in educational institutions. Genwww.Y graduates have served on expert panels for educational technology policy; managed school Web sites and networks;

provided information services to local and regional government agencies; presented curriculum projects at many local, state, regional, and national conferences; and participated in showcases for curriculum innovation.

Along with the Silicon Valley project, Generation WHY was recently recognized by the U.S. Department of Education's Technology Expert Panel as an exemplary education technology program.

Going back to college has long been a mainstay of in-service teacher training. College courses may be offered in a local high school or school board office and a growing trend is to deliver them online. A project in New York took this approach one step further; it worked closely with a local college (Hunter College) on a package of courses to support a specific set of project objectives.

American Gateways, 1996

Community School District #1, New York City Public Schools, NY

www.nycenet.edu/csd1/gateways.htm

American Gateways served more than 5,000 students, 200 teachers, 30 administrators, and 200 parents in 29 schools across four school districts. Community School District #1 serves the Lower East Side and the East Village of Manhattan, where many minorities and low-income residents live.

American Gateways captured students' interest by tapping into their natural curiosity about their family backgrounds. This interest was especially motivating and meaningful for children who grew up near Ellis Island and saw strong ethnic communities in their neighborhoods and other parts of the city. American Gateways created learning activities that supported the project goal, which was to "restructure curriculum and its delivery, incorporating the experiences of immigrant and migrant populations in the community."

When a consortium of interested parties in Community School District #1 developed a plan to use technology, they envisioned several key elements:

- utilizing technology and community resources to improve the instructional program
- developing and implementing intensive professional development intended to move teachers toward student-centered, project-based learning
- linking schools with community organizations and parents
- producing and disseminating the results of the project

The main vehicle for achieving the vision was tapping into the life

experiences of people, asking them to tell their family stories of immigrating or migrating to New York City. Consulting Ellis Island immigration records on the Internet became one obvious way to use technology. Telecommunications were useful in linking people for the exchange of information, and multimedia tools helped in accessing artifacts and displaying products of the project.

Aimed at children in all grades, American Gateways involved students in original research using interviews and actual documents as primary sources. Students used technology to search for relevant information and to prepare summaries of findings. Their reports were then posted on the project Web page.

Two categories of documents were posted: museum projects (which include The Confino Family; Chinatown, NY; and the Santos dePalo, El Museo del Barrio of Puerto Rico) and other curriculum resources. The latter included curriculum units and classroom projects, a time line of immigration laws, Web resources, guides to conducting research, early maps of New York, and more. Each is fascinating in its own right. Browsing through them reveals how the underlying concept of sparking student inquiry through an interesting, personally relevant topic has been brought to life. Some of the sites are accessible only to registered users; however, most sites, including dozens of curriculum units and samples of projects completed by students, are open to the general public.

Another aspect of the project, Gateways Community Voice, helped New York City settlement houses integrate technology into community-based programs that included after-school, youth, adult education, and programs for older adults. In addition, the main thrust of the curriculum efforts to explore family histories was carried into the community itself through the settlement house initiative.

American Gateways grew out of extensive collaboration among various partners, including local settlement houses; IBM; Scholastic, Inc.; Teaching Matters Inc.; and Hunter College of City University of New York, located near American Gateways teachers.

Hunter College customized three courses to support the American Gateways objectives.

1. Technology Tools was an introductory course that provided the basics of using computers in the classroom and introduced presentation and concept mapping software. The hands-on course gave practice with digital photography, scanning text and images, and using the Internet for searching, downloading, and importing images.
2. Developing a Curriculum about Immigration Using Technology was dedicated to exactly the kinds of topics and issues addressed in American Gateways, that is, creating a curriculum around immigra-

tion and migration with special emphasis on how to incorporate technology into instructional activities.

3. Immigration and Curriculum Design, Using Technology was devoted to using primary documents and Internet resources to teach about immigration.

Work completed by teachers who enrolled in these courses can be accessed at www.nycenet.edu/csd1/gateways.htm.

In addition to these three courses, teachers were provided with a series of all-day technology workshops offered over a six-month period. Instruction covered database, presentation, and word processing software use.

Clearly these courses and workshops offered teachers opportunities to learn how to use tools to create and implement a multidisciplinary curriculum that placed a high premium on integrating technology. The curriculum aligned learning objectives with local, state, and national standards.

American Gateways demonstrated impact in several ways.

- Teachers' knowledge of technology increased, as did their ability to use it for educationally meaningful purposes across subject areas.
- Teachers modified their teaching styles.
- Standardized test scores in reading and language arts improved, with teachers reporting substantial gains in reading, writing, speaking, listening, and viewing.
- Grammar and correct use of English improved.
- Technology-assisted instruction helped students improve their writing, research, and higher-order thinking skills; increased engagement in schoolwork; and improved motivation to complete assignments.
- Students gained technology skills and increased competence and pride.
- Community-based programs increased parent involvement in their children's education, their school district, and their community.
- Increased parent participation in technology training enabled them to go back to school, obtain jobs, and work more effectively with their children.
- Many parents purchased home computers.
- The project Web site and the Gateways Community Voice Web site expanded the extensive resources on immigration and migration.

This comment from a teacher at one of the American Gateways schools is instructive: "At our school, the way we tell time is *before Gateways* and

after Gateways. Before Gateways we had some computers, but integrating technology did not take place until Gateways came on the scene."

Other Projects: Enhancing Teachers' Professional Development

San Antonio Technology in Education Coalition (SATEC), 1997
San Antonio Independent School District, TX
http://satec.saisd.net

What happens to student learning when mathematics classrooms have the benefits of the latest technologies? What happens when teachers in these classrooms receive technical support and intensive training in the use of new technologies?

Teachers involved in training through the San Antonio Technology in Education Coalition (SATEC) explored answers to these questions. SATEC teachers had opportunities to learn about image analysis technology, graphing calculators, computer-interfaced probes, and data collection technologies. After learning about these programs, teachers engaged students in critical and analytical thinking and based their classroom instruction on concrete experiences with education technologies. Instead of learning mathematics through rote memorization and formula applications, students experienced applied math using technology to solve real-world problems. SATEC teachers explored how technology can be seamlessly integrated into math instruction in order to increase student understanding and appreciation of mathematics.

The San Antonio project was described in detail in a *Learner Online* article titled "Facing the Challenge in San Antonio" (www.learner.org/theguide/chall.html).

The Connections Project, 1996
Seward Public Schools, NE
http://ois.unomaha.edu/connections

Curriculum development, community connections, dissemination model projects, and professional development were the major features of The Connections Project in Nebraska. Teachers prepared for technology integration at five-day summer workshops. Their professional development began with a study of current brain and learning research. During their training, teachers had opportunities to learn about using computer software applications and implementing technology into instruction of the Nebraska curriculum framework standards. In the Teachers Teaching Teachers program, three-day professional training sessions were offered to all Nebraska teachers.

The project was part of the High Performance Learning (HPL) Model, a

school improvement effort in Nebraska. Although many school systems were involved in The Connections Project, implementation was locally controlled. Using HPL, localities established their own plans for school reform and improvement. Local school districts examined methods for including technology in high-quality instruction for all students according to their district needs. Localities then adopted improvement plans that involved parents and other community members and organizations.

Project planners set a goal for educators to develop 400 technology-supported units, which would be implemented, evaluated, and made available on the project Web site. Another goal is to disseminate model projects on CD-ROM.

Village Green Project, 1997
The School District of Greenville County, SC
www.villagegreen.net/vg

An involved community and a supportive model for professional development highlighted the efforts of the Village Green Project. Professional development in the diverse communities of the Greenville County School District fostered teacher confidence in their abilities to use a variety of new technologies. Teachers received six hours of graduate credit in teaching and learning institutes and worked through 50 instructional modules to prepare for integrating technologies into classroom instruction. The Village Green model for professional experience gave teachers ongoing support in their efforts to achieve high academic standards. Monthly study groups focused on student learning, educational technology, and assessment practices. Faculties at Village Green sites received intense training, and scholarships were awarded to teachers from nonsite schools.

The Village Green community involvement component connected schools, families, and businesses. Volunteers representing 370 Greenville corporations and organizations donated 40,000 community service hours in the schools in support of project goals. Parents also took advantage of computer classes at the site schools. Community centers that serve inner-city elementary and middle school students were furnished with software packages that coordinated with programs used in the schools so students could work on assignments at the centers. Businesses and schools coordinated efforts to produce a CD-ROM titled *Greenville from a Child's Point of View.*

MetroLINC, 1997
Boston Public Schools, MA

Several different professional development models were used in the MetroLINC project. This urban-suburban link between Boston and Watertown public schools worked to integrate technology into classroom instruction

and upgrade skills of teachers. Through a tier system of professional development, teachers trained teachers and then supported one another through informal discussions and technology showcases. Using "pioneer" and "adopter" models of professional development, pioneers planned lessons for the adopters to review. Adopters expanded the lessons to fit the needs of their students. Curriculum coaches assisted teachers in better understanding their subject matter. An intranet enabled teachers to share lessons and communicate through discussion groups with their peers. A technology tool kit was available online for the MetroLINC teachers.

Just In Time, 1997
Blackfoot School District #55, ID
http://challenge.isu.edu

To understand the complexity of professional development delivery in Idaho, one must first consider the geography of the project area. Idaho is a large state, and its weather and terrain challenge attempts to train teachers across the state. Project leaders attempted to overcome the geographical barriers by developing a product-driven training program. After teacher leaders received multimedia technology instruction in summer workshops, regional meetings were held to train teachers near grant school sites. Each training session focused on research, brainstorming, charting, storyboarding, and developing multimedia projects to use in implementation of project goals. Multimedia presentations were also developed to support training and instruction. Training materials were delivered via a password-protected Web site. Telephones, online bulletin boards, and e-mail communications delivered technical support across the state. The instructional foci included the history of Idaho, the science of Idaho, and multiculturalism in Idaho. Content areas were combined in new and appealing ways for students to explore. Technology brought educators together for in-service, planning, and support of this new instructional program for students.

Visions TECWEB, 1997
Todd County School District, SD
www.tcsdk12.org/tecweb

An important aspect of the Visions TECWEB project was the integration of technology in a culturally appropriate manner. Preparation included more than instruction in uses of computers and software. To make classroom instruction relevant for their students, teachers—who were predominantly White—attended summer institutes to develop an understanding of their students' cultures. The schools served by the project partners have student bodies that are 30 to 100 percent Native American. Summer institutes presented programs in understanding culture, child rearing, sacred sites,

community connections, and curriculum development, plus field experiences in the Black Hills of South Dakota.

In one example of cultural sensitivity to the Lakota and Dakota ways, a cultural resource person discussed with tribal elders such issues as whether it was permissible to share stories on the Internet because some Native Americans do not share family stories beyond their family circles.

By unifying efforts within several rural school districts in South Dakota, Visions TECWEB was able to use distance learning and intensive on-site in-service to reduce isolation, assess technology needs, and support culturally appropriate activities.

The Corning Community Project for Learning and Teaching, 1996
Corning City School District, NY

Faced with the challenges of a rigorous state testing program and the demands for a more skilled workforce, the Corning School District looked to technology innovations to meet the needs of its students. Education leaders facing extremely diverse economic situations among the residents of a large rural region in New York wanted to provide support for all students. Goals for this program included upgrading the technology infrastructure and reducing the digital divide by providing computers and Internet connections in the homes of economically disadvantaged students. The Corning Community Project promoted a beneficial partnership connecting the community, the Institute for Learning Technologies at Columbia University, and Corning Incorporated.

Initially, professional development focused on the middle school teachers then expanded to several elementary and high schools. Training prepared teachers to redesign their lessons based on constructivist practices. Using TaskStream, a Web-based interactive database specifically developed for the project, mentors helped teachers develop project-based lessons. Lessons were then piloted, reviewed, revised, and ready to use. Involvement of administrators in training and planning helped focus the entire school community on the issues related to technology integration.

Enhancing Learning: Parents and Community Members

In 1995, the first call for TICG proposals made reference to the need for an educated workforce in the United States. One statement said, "In a global economy, employers must have well-educated employees who make skillful use of information technologies to continuously improve their productivity and increase their knowledge . . . . New technologies . . . can smooth the transition from school to work and help develop the life-long learning skills necessary to compete in the economy of the 21st century."

Accordingly, several TICG projects focused on workforce issues. Three projects gave special attention to helping adult members of the community who were laid off or unemployed because of local economic conditions. They addressed economic development as they worked to help workers become more employable by learning *about* technology and learning *with the help of* technology.

Anderson Community Technology Now (A.C.T. Now!), 1995

Anderson Community School Corporation, IN
www.acsc.net/~actnow

Anderson's economy suffered when auto manufacturing jobs that had sustained the community for many years were lost. These jobs, though relatively high paying, demanded mainly semi-skilled and unskilled workers. Anderson's next generation of jobs required higher levels of training and proficiency with computers. A.C.T. Now! set three main goals:

- to increase educational opportunity for the entire community—families as well as students
- to transform teaching and learning in the schools through professional development and the creation of new learning environments
- to increase economic opportunity for students in Anderson

The TICG became a cornerstone of the plan to achieve these goals. The primary strategy was leveraged reforms already in place, one of which was a home computer program known as The Buddy System. Administered by the Corporation for Educational Technology, this independent system was funded in 1987 by the Indiana General Assembly and private donations from businesses and industries. More than 7,500 families of students in grades 4 to 7 in 63 counties across Indiana have participated in the program.

The Buddy System aimed to enhance student performance by increasing access to computers. The hope was that placing computers and printers in classrooms and students' homes would encourage more time on-task for learners. Using The Buddy System as a major part of A.C.T. Now! was also intended to help parents, especially those affected by changes in the employment picture in Anderson.

The mere presence of computers was not enough to achieve the program objectives, of course, so A.C.T. Now! funds also provided support to parents—for example, child care and access to the Internet and e-mail.

The project was implemented in five elementary and two middle schools with high percentages of children living at the poverty level. Students with no access to a computer at home could borrow one from the project. A total of 801 computers were loaned to homes, where 2,300 children had access (including brothers and sisters of the students who qualified for the program). The project provided home computers and technology training for 125 teachers of grades 4-8, who were taught by faculty from Indiana University and Butler University. Teachers' classrooms were each equipped with five computers and appropriate software.

Several related activities were integrated into A.C.T. Now! School on Wheels provided substitutes for teachers and principals so they could participate in professional development activities. Community Forum was funded by local employers, community organizations, and civic groups to study, plan, and help to implement new educational applications of technology. The project established a community technology center with 20 computer stations and Internet connections at the Anderson Public Library. Computers were also provided at selected social service agencies, including public shelters for homeless families. One Stop Career Centers in local high schools and public agencies were sponsored by JobSource, the local employment resource agency.

In the classrooms, technology was integrated into instruction and teachers opened up their teaching methods to project-based instruction. Teachers worked in teams and paid greater attention to incorporating technology into the achievement of state standards. Teachers used e-mail to communicate with parents.

Parents were affected in two ways: they became more aware and supportive of what was happening in their children's schooling, and they developed their skills, including raising their level of computer proficiency. For example, they learned to write resumés and conduct Internet searches, and some have sought advanced computer training.

Other Projects: Parents and Community Members

TICG projects with similar goals worked in Pennsylvania and West Virginia, areas affected by the reduced number of jobs in the coal mining industry.

Greene County Technology Initiative, 1996
Greene County Vocational-Technical School, PA
http://gctc.waynesburg.edu

Knowing the importance of schools to the economic viability of communities, five school superintendents from the Greene County area gathered to create a long-term project that utilized the schools as agents of change. This vision was the genesis of the Greene County Technology Initiative. Greene County had long relied on an unskilled work force, and the project sought to impact economic development by creating a technology-supported education system that would prepare students for higher education, advanced technical training, and business ownership and management.

The project installed a fiber-optic videoconferencing system at all five high schools to distribute and share curricular materials and continuing education opportunities. Each building also received a local area network (LAN) and Internet connectivity. The project offered several advanced technology training programs that resulted in certification and placed many graduates directly into technology careers. Three Web-based businesses that sell their products over the Internet were also created as a result of the project. The project boasted of significantly improved rates of attendance, graduation, and enrollment in postsecondary institutions. Using the schools to promote individual and community development, the Greene County Technology Initiative capitalized on a technology infrastructure.

Your Future in West Virginia . . . Growing Together, 1995
Monongalia County Board of Education, WV
www.phase9.org

After many coal mines closed, the West Virginia High Technology Consortium wanted to bring new economic development to the state. Community members did not see schools as resources nor could they imagine the economic benefits technology might bring. Your Future in West Virginia opened doors for many. It established 21 Technology Opportunity Centers (TOCs). During the school day these computer centers served students; in the evenings parents and students could take classes on career orientation and basic computer skills.

TICG training was provided in two "tracks." Teachers received intensive training to promote technology skills and technology integration in classrooms. TOCs provided training for displaced workers, community businesses, and parents, and awarded certification for proficiency in computer and multimedia technologies.

The project hoped to affect as many as 100,000 community members and students in 152 schools. The grant also leveraged the COAL 2000 initiative, a cooperative partnership for retraining displaced workers. High-tech companies and West Virginia University joined in efforts to make the program a success.

Strengthening Curriculum

This section highlights projects that illustrate integration of technology into curriculum, and sometimes involve the development of an entirely new curriculum.

Educators plan learning activities within an overall curriculum framework. Frameworks can be defined in various ways—some are implicit in textbooks while others may be specified in curriculum guides written by supervisors; teams of teachers; or committees that include teachers, parents, business leaders, lawmakers, and members of interest groups. National associations, such as the National Council of Teachers of English, are also sources of curriculum frameworks.

Technology Innovation Challenge Grant projects that focused on developing curriculum tended to take one of two approaches: curriculum based on student inquiry or curriculum based on standards. Each approach had implications for the way teachers used education technology.

In an inquiry approach the *content* to be learned may be less clearly specified than the *process* students follow to learn—i.e., identifying a problem, developing a plan for attacking the problem, dividing responsibilities among members of a team, searching for information, interpreting the information, and organizing it into a coherent product. In this approach, teachers need and want to give learners access to a wide array of information—a need technology is particularly well suited to addressing.

In a standards-based curriculum, subject matter takes priority. Teachers are responsible for making sure students cover and master certain material. Again, technology assists pursuit of the goal. For example, computers are infinitely patient; interactive software that analyzes student responses and chooses different paths according to student success can adjust the pace of lessons so instruction is individualized. Standards-based curricula are often initiated or mandated by the state; they target information that will be tested in accountability programs. Developing a Web site of standards-based lesson plans helps teachers examine them and adopt or adapt them for their own classrooms. (Such lesson banks also assist teachers who use the inquiry approach. Goals and objectives are typically specified, and illustrative instructional activities help with teacher planning.)

Research shows that aligning curriculum with standards results in better student achievement, so focusing on curriculum can have value in any instructional approach.[5] The main point is that technology can be used to support nearly any curriculum.

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[5]A. Glatthorn. Curriculum Alignment Revisited, *Journal of Curriculum and Supervision, 15*(1): 26-34 (1999). pp. 26-34.

The Schools for Thought project offers an opportunity to introduce two closely related thoughts that will be developed more fully throughout this report. First, several TICG projects were launched in districts where improvement programs were already under way, and the new projects were intended to contribute to those ongoing efforts. Second, state and local reform efforts typically played a large part in determining how TICG projects would be implemented. Both factors affected the projects' effects on local schools.

Schools for Thought, 1996

Metropolitan Nashville Public Schools, TN

www.nashville.K12.tn.us/sft/Pages/index.html

In 1993, schools in Metro Nashville began working closely with Vanderbilt University to change the classroom teaching/learning equation. Using a Professional Development School concept in which schools assume full partnership with a university in the preparation of new teachers, Vanderbilt and Metro Nashville put in place a research-based professional development program to convert classrooms from teacher-centered to learner-centered environments. This far-reaching reform effort was designed to use computer-based curricular materials. The Learning Technology Center at Vanderbilt was pilot-testing a cognitively based pedagogical model—Schools for Thought (SFT)—in local schools. It included both professional development for teachers and instructional materials. SFT was closely allied with that research and development effort.

Schools for Thought is a good example of a project that was affected heavily by state and local contexts. Early in the implementation period, the political climate surrounding the Metro Nashville Schools changed. A strong back-to-basics movement and the introduction of a new statewide assessment program (Tennessee Comprehensive Assessment Program, or TCAP) placed increased emphasis on traditional education. The basic concepts underlying SFT were at odds with these changes—classroom activities were designed to help children learn to organize their thinking and search for relevant information rather than acquire information for its own sake.

Examples of SFT curriculum projects were placed on the SFT Web site. One task asked students to decide whether a hypothetical mission to Mars was feasible. Groups of sixth-grade students worked over an extended period of time to gather information to make a case for or against the mission. Once the group work was finished, each student wrote his or her own report, deciding how to organize the information gathered through group inquiry into a personal statement.

In another SFT activity, eighth graders tried to answer the question "Whose 'seventh generation' are you?" An adult volunteer helped students access genealogical records at various archives and the public library. The students learned to search for information on the Internet and elsewhere, think about problems from various angles, develop and try various solutions, deal with incomplete information, organize, and synthesize information so it could be communicated in an interesting and meaningful way—all useful skills.

Such descriptions of inquiry-based learning in SFT caused some to believe the classrooms were without structure, having neither specific subject matter nor process outcomes in mind—a common criticism of inquiry-based learning. SFT responded with this statement on its Web site:

> A great deal of structure is necessary to make SFT classrooms work optimally. Teachers and other community experts guide students toward a focus on deep principles of the domains being studied (e.g., science, mathematics). They constantly work to help reframe student-generated questions from the perspective of these principles. Student inquiry is guided to facilitate students' "discovering" the deep principles of the domain and connections across domains.

Although the curriculum in an inquiry-based approach seems to focus more on process than on content, specific content need not be abandoned or left to chance. The SFT project demonstrated that student projects could be structured as narrowly as the teacher desired. This placed more responsibility on the teacher, and it created an opportunity for students to have a say in the topics explored and the nature of the products that would result.

For example, if specific facts about Mars and/or rocketry were important, a rubric for evaluating the final reports could be developed collaboratively with students to assure coverage of required information. In this way, the SFT project confirmed that students can be active participants in content development and active learners, with guidance to ensure they are not left to work "on their own." Technology supported locating information so students could acquire the knowledge specified by a standard. SFT teachers regarded technology as a part of the learning experience, not a separate subject to be taught. Technology use helped to build a knowledge base and was a tool for collaborative problem solving.

A central element in the SFT project was the professional development program initially provided by Vanderbilt University and later taken over by the school district. Teachers attended an 80-hour summer pre-implementation program that introduced the philosophy, pedagogy, and techniques of an inquiry-based approach to learning. Technology training helped teachers use computers to support inquiry learning. Monthly follow-up sessions were provided during the school year, and content specialists observed classes and offered feedback and suggestions. Reflection played an important part

in SFT and encouraged examining teaching practices against the conceptual framework for child-centered learning. Elementary and middle school teachers participated in the professional development program; high school teachers did not. Project staff acknowledged having greater success with K-4 teachers than with teachers of grades 5 to 8.

The Schools for Thought project reported the following outcomes:

- SFT students had greater access to and reported using technology more than other students.
- SFT students had more positive attitudes toward computers than other students.
- SFT students performed better than comparison students on performance assessments involving written composition and mathematical problem solving.
- There was no drop in standardized achievement scores (TCAP) over multiple years and some improvements at the end of one year of SFT, especially in the early grades.
- SFT parents noticed more positive changes in their children over the course of a school year than comparison parents.
- Teachers were very satisfied with the learning opportunities provided by SFT professional development.

The professional development program helped teachers to create a culture of inquiry in their classrooms, schools, and professional communities and to adjust to standards-based expectations.

Aurora Project, 1997

Fairview Public Schools, OK

www.auroraok.org

Another project that illustrated how to build a curriculum around student inquiry, the Aurora Project's main goal was to develop an online learning community with a strong commitment to creating problem-based learning experiences. The project included a professional development component designed to help teachers adopt a concerns-based approach—a variation on inquiry-based learning.

Teachers worked with other members of the learning community to develop and test lessons and curriculum units in their classrooms, then posted them on the Aurora Web site. Inquiry problems were drawn from the local community and students had a strong voice in choosing the topics. They often

gathered information from parents and community members by preparing and administering written or oral surveys. Teachers developed lessons in nearly all areas of the curriculum—including arts, foreign language, health, math, philosophy, physical education, science, and vocational education—but typically used comparative geography as a starting point.

These examples of actual problems or projects that students tackled illustrate the approach.

Social Studies

- What was it like when TV came to my town?
- How much is that item in the window, or, how do supply and demand affect price?
- What can we learn from demographics?

Mathematics

- If there are two sides to everything, would I really be in China?
- Measuring elapsed time using a clock

Health

- What do child mortality rates tell us?
- Why do Oklahomans have such bad allergies?

Each unit or lesson plan identified goals, grade level(s), prerequisite(s), theme(s), discipline(s), length of activity, engaging questions, notes for the teacher, a materials and resources list, step-by-step instructions, and an evaluation rubric. Each included a guide for the student and for parents, as well as data collection forms and a place to enter findings for other members of the learning community to read. Lesson content was often linked to state and/or national curriculum standards, and a form was provided to gather feedback (including suggestions for improvement) from anyone who used the lesson. That feedback was available to all users.

The Aurora Learning Community conducted its activities through GeogWeb, an inquiry-based curriculum model and a vehicle for developing and sharing lessons on the Web. Partway through its funding cycle, the project reported more than 1,600 lessons were posted and nearly 550 teachers were trained in GeogWeb development. More than 11,500 students and 750 parents were involved.

The Aurora partnership included six public school districts, the Catholic school system of Oklahoma City, Pioneer Telephone Cooperative, Southwestern Oklahoma State University, and Southwest Educational Development Laboratory. Various other groups and agencies also participated, including the state telecommunications system, the Oklahoma Water Resources Board, the Association of American Geographers' ARGUS Project, the Oklahoma

Historical Society, the U.S. Geological Survey, University of Oklahoma project evaluators and curriculum developers, and the Oklahoma Department of Commerce.

Members of the Aurora group called themselves a virtual learning community, and the label seems appropriate. Any teacher, librarian, business owner, content specialist, state employee, or other member of the community could join the project activities as a learner and a collaborator. The Aurora Project was actually a consortium of learning communities, some operating within a single school or school district, some within particular topic areas, and some across the entire state. Teams of collaborators could emerge at any level to pursue a line of inquiry, with each person working through the GeogWeb. Technology Learning Clubs were organized to facilitate collaborative efforts. The Web site offered a functional model to get club members started with brainstorming, voting, gathering data, problem solving, dividing responsibilities, and generally moving groups toward consensus.

The Aurora professional development model was multitiered and driven by the Concerns-Based Adoption Model.[6] Teachers, like their students, learned through problem-centered activities facilitated by the GeogWeb Curriculum Model. Training was differentiated depending on teacher need and level of expertise.

The project's interim conclusions included the following:

- adoption of the Concerns-Based Curriculum occurred at different rates for different teachers
- "at-your-elbow" training—meaning individualized help for teachers—was less threatening and did not assume great computer proficiency
- having infrastructure in place—functional software, hardware, and connectivity—was a prerequisite to adoption of the curriculum model
- teachers should not be hurried in their adoption of a new approach to teaching
- teachers were concerned about subject matter and wanted to feel comfortable that it was being taught
- monetary rewards were no more powerful teacher motivators than seeing the program benefit their students

The results of the Aurora Project have been very positive. The project used teachers' concerns to determine steps to ensure adoption of the innovative model. Teachers reported more frequent use of technology in the classroom both personally and by students. Results of an in-depth study of three fifth-

[6]S. Hord, W. Rutherford, L. Huling-Austin, & G. Hall. *Taking charge of change*. (Alexandria, VA: Association for Supervision and Curriculum Development, 1987).

grade classrooms suggested that teachers believed Aurora allowed for more collaborative planning and more student engagement in learning activities.

The Aurora Learning Community shared some features with a project in Volusia, Florida, but the two also had interesting differences. The similarities included encouragement and opportunities for teachers to share curriculum units and lessons on the Web. The major difference between the two was in their use of standards. Volusia was closely allied with national professional organizations and their curriculum standards, whereas the Aurora Project left the use of national standards to the discretion of individual teachers.

Career Connection to Teaching with Technology (CCTT), 1997

Volusia County School Board, FL
www.cctt.org

Career Connection to Teaching with Technology provided a particularly good example of a project focused on developing a standards-based curriculum. A consortium of schools working with curriculum experts and telecommunication firms developed and implemented the project.

CCTT sought to make technology a positive force in changing the teaching and learning environment. Curriculum materials and online models for developing materials were made available to the education community online. The main work of the project was carried out in six far-flung hub sites:

1. Advanced Technologies Academy, Clark County School District, Las Vegas, Nevada
2. Omaha North High School, Douglas County School District, Omaha, Nebraska
3. Sprayberry High School, Cobb County School District, Marietta, Georgia
4. Manual Arts High School, Los Angeles Unified School District, Los Angeles, California
5. Fort Leavenworth United School District, Fort Leavenworth, Kansas
6. Mainland High School, Volusia County Schools, Daytona Beach, Florida

Educators paid by grant funds managed each site.

Technology Information and Education Services of Roseville, Minnesota, played a key role in the project by gathering a group of curriculum content specialists representing several major professional organizations—

National Science Teachers Association (NSTA), National Council of Teachers of Mathematics (NCTM), National Council for the Social Studies (NCSS), National Council of Teachers of English (NCTE), Association for Educational Communications and Technology (AECT)—to help develop standards-based curricula. The content specialists worked with teachers using a framework designed for the project. This framework provided teachers with authoring systems and templates for unit and lesson development, and help screens for online professional development. The Apple Learning Interchange (ALI) worked with CCTT personnel to customize the Web site and to combine the resources of CCTT and 19 other ALI partners.

CCTT Regional Institutes emphasized integration of technology into units and lessons. The professional development was based on the following tenets:

1. Technology is positively changing the teaching and learning environment.
2. Technology positively impacts student achievement.
3. Students and teachers are partners in learning.
4. Technology empowers teachers and students to become authors and publishers.
5. There is strength in diversity.
6. Authentic career applications enhance opportunities for students.
7. The use of research findings on teaching and learning provides a greater depth and breadth to professional development.

Teachers were trained in the use of tools and in curriculum development at all six hub sites and at workshops held in conjunction with conferences such as the Florida Educational Technology Conference.

National standards in reading, writing, mathematics, and science provided the framework for curriculum design, and teachers learned how to focus on each discipline's basic content. CCTT produced lessons, units, educational resources, and entire courses of instruction. Tools for teachers included the ActiveClassroom Web site (www.activeclassroom.com), an online curriculum management and organizing tool for teachers that also enables students, parents, and district personnel to see agendas, course outlines, and calendars. The CCTT National Institute, an online workshop, prepares and guides teachers through writing and editing curriculum aligned to national standards.

Despite technology support for collaboration across distance, obstacles remained. CCTT set out to implement a uniform curriculum development process in six states. Differences across states and school districts required changes to accommodate these local differences. For example, time differences made meetings difficult to arrange. Firewalls, restrictions on Java, and analog versus digital telephone lines also created frustrating complications.

Career connections to the curriculum were made with the help of an advisory committee composed of business, government, and education leaders. The Secretary's Commission on Achieving Necessary Skills (SCANS) provided the framework for connecting content to careers.

Other Projects: Strengthening Curriculum

Primary Sources Network (PSN), 1996
Melvindale-Northern Allen Park School District, MI

The Primary Sources Network (PSN) helped teachers design and develop technology and curriculum products and services. The aim was to develop standards-based classroom materials that could be used in the inquiry method and be adapted by teachers to meet local curricular needs.

One partner, the Henry Ford Museum, focused on incorporating primary sources in teaching and learning to help students to better understand events or phenomena. Another partner, the Center of Highly Interactive Computing in Education (HI-CE), leveraged its experiences developing technology-supported curriculum and professional development to take the lead in designing technologies and training for PSN.

PSN created the Artemis search tool, designed to find Web sites that are known to offer instructional support rather than merely generate an overwhelming hit list as do many search engines. Artemis also offers cataloging and notification services that enable students to bookmark and share Web resources.

PSN began with a small core of teachers but will make its products and procedures available to larger audiences, as it has done with Artemis.

Advanced Curriculum through Technology (A.C.T. Now!), 1996
Sweetwater Union High School District, CA
www.suhsd.k12.ca.us/actnow

A district as large and diverse as Sweetwater Union encounters numerous obstacles that might inhibit technology integration. The largest secondary district in the state of California, through the Advanced Curriculum through Technology (A.C.T. Now!) program, placed computers in classrooms, connected classrooms to the Internet, provided teacher training, and developed educational units and lessons for the Web.

Central to the project and key to strengthening the curriculum was the staff development program. More than 95 percent of the district's 1,300 teachers could take 40 hours or more of professional development, where they learned to develop and administer standards-driven, Internet-based instruction in either the WebQuest or WebExperience training series. Using A.C.T. Now! tools, teachers followed a seven-step process to create lessons

that are stored and indexed by subject and grade on the Web site—providing easy access for sharing and reuse.

Technology in Nature in Sanger (TINS), 1997
Sanger Unified School District, CA
http://tins.sanger.k12.ca.us

Visitors to the Sanger Nature Area along the Kings River in California can wander trails lined with blackberry bushes and cottonwood trees and catch glimpses of beavers, egrets, raccoons, and other wildlife. The last thing a visitor might expect to find would be a computer or other technology, but in a way, the Sanger Unified School District is using technology to help students and teachers capitalize on its valuable ecosystem. TINS uses technology-based tools to study nature.

TINS approached this project by first helping to develop curriculum units that integrated science, technology, and language arts. The units combined field and classroom learning activities and were aligned with state and national science and language arts standards, as well as those of ISTE-NETS (http://cnets.iste.org). In the field, teachers and students used a mobile technology lab equipped with a variety of tools, such as laptops, sensors, and digital cameras.

Students as Agents of Change, 1996
Gary Community School Corporation, IN
www.surfnetinc.com/gary_schools/chalgrt.htm

Incorporating standards in an interdisciplinary structure that uses technology tools to support student improvement was the goal of the Students as Agents of Change project. Prior to receiving the Challenge Grant, Gary's school board adopted a policy to incorporate a curriculum focused on African and African American issues. (The 1990 census showed Gary's population was more than 78 percent African American.) This curriculum served as the vehicle for technology integration in the Challenge Grant project.

The project focused on helping sixth-grade students develop the skills to find, evaluate, create, and disseminate information in a technology-supported environment. To start, sixth-grade teachers needed to acquire technology skills and capacity. The program used a train-the-trainer model, primarily through summer "tech camps." The model helped teachers build skills and use technology to support the interdisciplinary units. The teachers have come to respect the abilities of the students and give them a larger role in the collaborative environment required by the multimedia projects.

Creating Infrastructure

To deliver their full potential, tools need to be well maintained and available; education technology is no different. To effectively integrate technology into instruction, certain preliminaries are necessary. Equipment must be purchased, physical space must be found or retrofitted for computers and peripherals (printers, scanners, surge protectors, power supplies, wiring, and the like), and other steps must be followed to prepare schools for the new technology. Issues such as software licensing agreements, acceptable use policies, and Internet filtering need to be addressed. In addition, existing issues of security and safety take on new dimensions (e.g., protecting expensive equipment and children from harm or injury).

Ideally, before the first computer is purchased or connected to the Internet, a school should have a detailed technology plan. The TICG program started in 1995, well after computers were introduced into the classroom, so the need created by grants was seldom one of building a new infrastructure but of expanding and improving the infrastructure already in place. For some schools, the existing infrastructure merely needed to be enhanced. For others, the prospect of receiving a grant must have posed a sobering series of questions about how to prepare. Issues that needed attention included

- improving the student-to-computer ratio
- providing state-of-the-art computer systems
- finding compatible equipment and connecting cables
- choosing a platform
- having adequate electricity for computer systems in each classroom
- updating and extending wiring (telephone lines, fiber optics, etc.)
- making connections via intranet/Internet
- providing ongoing maintenance and technical support

It is difficult and expensive to update a technology infrastructure. State and federal dollars may be needed, especially in school districts that serve high percentages of families with limited incomes. Local schools seldom have the expertise or the means to accomplish this on their own. For these reasons, a number of projects started at a very basic level.

This section focuses on how some TICG projects used technology to improve their school systems and communities.

The Louisiana Challenge, 1995

Natchitoches Parish School Board, LA
www.challenge.state.la.us

A consortium of five school districts collaborated with several universities on this proposal. The consortium proposed an infrastructure that would enable schools to use learning technologies to provide educational opportunities for students and parents. The project built on the efforts of existing programs, two of which were funded by the National Science Foundation.

The consortium expected to work with the infrastructure already under development in the state. However, Louisiana's technology infrastructure lagged far behind the rest of the nation. In fact, according to a 1996 survey, Louisiana ranked last in the nation, with a student-to-computer ratio of 88:1 in grades K-12.

The Louisiana Challenge needed to purchase hardware, retrofit aging buildings with adequate electrical wiring and data cable, and complete other related renovations. The project provided the training that teachers needed to take advantage of the infrastructure. When the partners gained financial and training assistance to address their own needs, they were so successful that they found themselves catapulted into a leadership role to create a technology infrastructure for school systems across the entire state.

The Louisiana Challenge addressed several objectives. Among these were ensuring equity of access to technology for underserved students and maximizing the use of buildings and equipment by underserved communities. Others focused on increasing student achievement, providing professional development for educators and community partners, ensuring school readiness for technology, encouraging parent involvement, facilitating school-to-work transitions, and strengthening lifelong learning skills for students.

Because of the momentum created by the five TICG districts, other public and nonpublic school districts throughout Louisiana have made progress in technology. The project created a Web site and developed resources such as newsletters, training videos, brochures, eight professional development courses, supplementary training materials, model lesson plans and curriculum units, and projects created through online collaboration. Largely through the leadership of the project director and his staff, Louisiana developed a state plan for educational technology, which was approved and adopted in 1997. The state legislature awarded schools $38.2 million for a Classroom-Based Technology Fund (CBTF) for hardware, software, and network infrastructure for schools. The U.S. Department of Education awarded Louisiana $5.4 million through a Technology Literacy Challenge Fund (TLCF) to be used for teacher professional development during the 1997-1998 school year.

The governor of Louisiana asked project staff to scale up the project to

assist all parishes in the state to develop local technology plans consistent with the state plan. Additional funds in the amount of $25 million from CBTF and $10 million from TLCF were approved for the 1998-1999 school year.

The Louisiana state plan for technology includes materials that were developed initially by the Louisiana Challenge project. It provides a good look at what is involved in creating infrastructure. Infrastructure requirements are discussed in Appendix B of the plan, which is organized into four main components. Highlights of each follow, and a visit to the Web site is recommended to anyone preparing to write a technology plan.

1. Vision for Technology Infrastructure in Louisiana Schools

- School/Campus LAN: A single campuswide local area network (LAN) with LAN server(s), facility wiring, gateways to and from external networks, file transfer services, electronic mail services, and security should be implemented for both instructional and administrative support.
- Training/lab systems: In each school there is at least one location where several networked computers with CD-ROM drives, a projection system, printers, instructional management and curriculum support software, furniture, a scanner, and a digital camera are available for training and/or lab activities. These systems include implementation of a single campuswide LAN used for both instructional and administrative support.
- Administrative support systems: Each campus has at least two networked computers, one printer, and appropriate software dedicated for administrative use.
- Classroom instructional systems: Each classroom provides at least one networked computer with CD-ROM drive, a printer, a projection system, furniture, and software for instructional management, e-mail, and curriculum support. Also available are TV and VCR resources suitable for classroom use and a closed-circuit TV system with connection to external video sources, broadcast video, or a digital satellite system.
- Student systems: Student workstations include networked computer systems providing a 5:1 student-to-computer ratio with all students, including those with special needs, having regular access to computer systems.

2. Hardware and Software Implementation Overview

A two-way interactive video classroom should be established in each school to allow for student/teacher access to a video classroom for instructional and teacher in-service purposes.

3. Louisiana Direct Networking Model

This section concentrates on finding and applying for funding, ways to share technology resources, and issues related to local and state networks.

4. Illustrations of Technology Infrastructure for Schools

This section provides very specific information about the technology to be placed at each network-ready and instructor workstation.

The Louisiana project demonstrates how a consortium of school districts can work together to create infrastructure. It is rare that a local effort spreads as far and wide, but many local school systems confront the same situation faced by the educators in Natchitoches. They find themselves saying, in effect, "We need computers and we need network connections and trained teachers as well as partnerships with parents and businesses in the community." A number of projects took on the same challenge.

Richland Clicks!, 1997

Richland County School District One, SC
www.richlandclicks.org

Richland County pioneered some very innovative methods that may be instructive for other educators frustrated by limited technology and resources.

At the time it received funding, Richland County was further along in creating a technology infrastructure than most of the school districts in the Louisiana consortium. Yet, like most school systems in the early 1990s, some schools were well ahead of others in their acquisition and use of technology.

Richland staff built infrastructure in several ways. In addition to the fundamental needs that go with adding more Internet-ready computers, Richland Clicks! implemented several measures to increase the availability of technology in classrooms and the community. The following list offers examples:

- student technology training programs that included summer technology camp, adaptive technology for students with special needs, and training for high school students who wanted to serve as technology assistants
- seven videoconference labs in county high schools available to students for advanced courses and to teachers for professional development
- 16 community access centers with Internet-ready computers for use by the public

- computer instruction provided on weekends and in the evenings
- a laptop lending program
- professional development within the framework of a three-year developmental plan similar to the ACOT™ model (Apple Classroom of Tomorrow)
- five technology trainers who worked directly with teachers to instruct and offer support—each trainer worked with specific schools
- incentive program that encouraged teachers to develop lesson plans for the project Web site
- teacher certification renewal linked to ISTE standards, which teachers met by developing portfolios documenting their technology proficiency

One intriguing aspect of the project was the Mobile Technology Lab, a 37-foot Winnebago that traveled the community to provide access to technology and increase the knowledge and skill of students and their families. The van housed a child development classroom for preschoolers whose parents were using the facility. The van served private day-care centers two days each week and was used four evenings a week to provide adult education to residents who lacked access to computer technology. These included senior citizens, who comprised a large percentage of the mobile technology students. Participation logs from October 2000 to February 2001 provided a snapshot of van activities at 10 community events: Visitors included 2,900 students, 300 parents, 220 teachers, 10 administrators, and 2 school board members.

Richland Clicks! received strong support from parents and the business community. Volunteers took an active part in the program through arrangements that linked students with business leaders. The program also had a strong community outreach component that took technology to the community and provided parents with hands-on instruction in the use of computers.

A few examples of project outcomes suggest the impact Richland Clicks! has made on schools and the larger community.

- Low-achieving students who borrowed laptop computers averaged eight days more in attendance and scored one grade point higher than a matched group without laptops.
- Taking technology training to the community schools, churches, and local organizations reached adults in the most impoverished areas of Richland District One and resulted in equal access to training.
- Evaluation procedures were enhanced by a project management plan that included specific activities and expected outcomes.

- Interactive distance learning activities required changes in the way classes were scheduled and the way teachers participated in online courses.
- Professional development activities helped teachers move from being disseminators of information to learning facilitators.
- Project partners needed time to identify common goals and needs and to connect people to the information they needed to develop a sense of community. Trust depended on having concrete evidence of accomplishment.
- Opportunities to strengthen the project developed over time. Participants needed to keep an open mind concerning how technology could benefit schools and the community.
- Success with traditional approaches to instruction was a fairly good indicator of which teachers and principals would be most successful with integration of technology.

Students, teachers, administrators, parents, and community members were helped to learn the basics of technology and served by a far-reaching and constantly evolving infrastructure. Some of this infrastructure was anticipated in a long-range technology plan, but most responded to needs that emerged over time. Anyone who thinks technology infrastructure begins and ends with adding more computers or connecting classrooms to the Internet can learn from Richland Clicks! that it involves far more.

Other Projects: Creating Infrastructure

The Manchester Challenge, 1995
Manchester School District SAU #37, NH
www.mansd.org/challenge

The Manchester School District took the challenge of "access for all" seriously and developed a districtwide network of teaching and learning opportunities for the schools and community. The project provided computers and software, and also kept in mind the intended purposes of linking and building partnerships between the schools and community. Early on, it was decided that computers would be installed in classrooms rather than labs. All elementary classrooms received at least one connected workstation, and secondary classrooms got four. Capitalizing on the E-rate program, the district successfully connected all the schools ahead of schedule.

The new infrastructure made observable differences in teaching, learning, and school management. Technology was incorporated across disciplines and not looked on as an isolated topic or skill. School goals incorporated technology use and teachers routinely demonstrated advanced

stages of technology integration. A strong professional development program included all staff. This training progressed from basic skills acquisition to using digital tools to support daily activities. Manchester's technology efforts undoubtedly contributed to the three National District Schools awards received during the past four years.

Newaygo County Advanced Technology Service (NCATS), 1995
Newaygo County Intermediate School District, MI
http://ncats.net/challenge_grant

In rural Michigan, the vision of the NCATS leaders brought a state-of-the-art infrastructure to one of the state's poorest counties. NCATS leveraged TICG to attract more than $25 million in additional funding to create a network that supports data, video, and voice connections among 33 public and six private schools in the district. NCATS promoted the sustainability of this project by owning the network, which released the schools from long-term payments to a service provider. Of the original TICG monies, Newaygo devoted half to developing the infrastructure and wisely allotted monies for professional development and evaluation to yield a better return on investment from their technology dollars. When the dust settled, NCATS had installed five computers in every classroom as well as two computer labs in each school. Evaluation data showed that some of the labs were not utilized well and the equipment from these was redistributed.

Program outcomes included an additional 20 technology staff members (with their own budgets) and a teacher evaluation tool called Dialogue Web, which was adopted statewide. Response from school personnel was positive, perhaps due to the sensitive alignment of training to stated need. Administrators were included in training events and could also access training materials in a distance-learning environment. Teacher training on effective integration strategies was presented in a novel "customer-focused model." The project was unable to offer released time but motivated teachers to attend training by providing small blocks of high-quality training at convenient times targeted to specific teacher needs.

Philadelphia Technology Consortium, 1995
School District of Philadelphia, PA

Sometimes it pays to rethink definitions, as happened in this project. The district had originally defined access as "six key drops"—one each in the library, custodian's room, and offices of the principal, counselor, and nurse, and one wildcard location. Revising their definition led to a district-wide infrastructure that provided networked computers in every classroom, for a total of approximately 25,000 networked computers and a student to computer ratio of 8:1. Community members got the benefit of access to 28 workstations through the new Community Technology Training Centers.

Philadelphia developed a performance index to evaluate school quality improvement by considering data from test scores, attendance, promotion, and drop-out rates. This index indicated that 87 percent of the elementary and 100 percent of the middle schools had met or exceeded their target goals. While improvement was noted in all schools, the high schools had the greatest difficulty. To support progress toward school goals, the district employed a three-tiered professional development structure with training for technology leaders at the district level, application and integration strategy training for teachers and administrators at district centers, and customized training and follow-up support at the school level.

The project's flexibility led to some surprising revisions in partnerships. Most notable was the University of Pennsylvania's (UPenn) work with one cluster at one high school. The technology infrastructure made it possible for UPenn to work on real-world problem solving in district classrooms. UPenn students helped teachers develop basic technology skills to support effective practice and provided training and network support. High school students became interns at UPenn. While this partnership reached only a small group of students, it demonstrated how a little seed money could initiate a mutually beneficial partnership that provided its own momentum for continuation.

The Eiffel Project, 1996
New York City Board of Education, NY
http://eiffel.ilt.columbia.edu

The networked digital technologies that have transformed the way the world works can also transform school practice to support student achievement—even in districts faced with poverty, discrimination, and urban crowding. That was the belief of the Eiffel Project in New York City.

The Eiffel Project expanded infrastructure beyond basic wiring and hardware to include people. The project consortium included nearly 70 schools in several districts, the Center for Collaborative Education, the Institute for Learning Technologies, numerous community-based organizations, and several research institutions, museums, small businesses, and corporate concerns.

While this program successfully provided or improved access to technology for more than 30,000 students, it is important to note that the development of staff's abilities and skills was equally crucial to its success. The project's greatest impact was in schools where administrators actively planned and supported project initiatives. Project members also reported that community-based organizations contributed to program success through their integral role in educating nontraditional and marginalized students and improving parents' skills.

Accepting the Challenge, 1996
Franklin County Public Schools, VA

Franklin County leaders understood that effective technology integration was like a puzzle—and that skilled school personnel were an important component of the puzzle. Prior to receiving the Challenge Grant in 1996, few if any classrooms in Franklin County Public Schools were connected to the Internet. While the school system's existing infrastructure allowed schools to have online services, a structure connecting buildings or allowing for a wide area network was lacking. In addition, the need to provide enhanced distributed education capabilities was important.

To support teachers with the necessary skills to utilize the infrastructure and equipment, thousands of hours of staff development, both locally and regionally, were provided.

The project also provided significant funding for curriculum planning and development for a new and innovative school, the Center for Applied Technology and Career Exploration (CATCE). CATCE is a unique facility and program, rich in technology, that makes use of problem-based learning, hands-on learning, and standards-based curricula.

Today, every instructional space has high-speed Internet access via cable modems. Telecommunications efforts have focused on instructional uses of the Internet, distance learning classrooms, and desktop videoconferencing.

ABC Technology in Education Partnership, 1997
Guilford County Public Schools, NC
www.abcnet.org

"Getting to the heart of the problem" seemed to be Guilford County's strategy. This program sought to impact student achievement by focusing on the greatest areas of need—mathematics, reading, and writing in grades 3-8. The project also specifically targeted students in at-risk schools. The program had a well-established network infrastructure that reduced student-to-computer ratios from 22:1 to 6:1 while dramatically increasing access to the Internet and Web-based telecommunications in classrooms.

The project team required strong commitment from participating schools and made this point clear to all potential members. Some local education agencies (LEAs) declined to participate, but the project spread to 42 schools across five LEAs and affected more than 21,500 students. The project's infrastructure drove establishment of wide-area networks (WANs) for entire district access. This partnership promoted widespread collaboration and a variety of new learning opportunities for students and teachers in urban and rural settings.

Once the infrastructure was developed, the project team developed a long-

term model of multiple small doses of professional development. These training efforts produced student gains in reading, writing, math, multimedia presentation, and computer skills. It also resulted in increased, more effective use of technology and software. Successful structured programs, such as Project Read/Write, have promoted the development of similar programs that focus on presenting content standards in a technology-supported environment. Program activities and evaluation were aligned to the state's benchmarks and accountability system. The ABC Technology in Education Partnership presents a model for school districts across the nation.

A Community of 21st Century Learners for El Paso, 1995
Socorro Independent School District, TX
http://challenge.education.utep.edu

Beginning with their immediate neighbors, three communities in and around El Paso, Texas, created a project to extend their connections online. A Community of 21st Century Learners for El Paso had infrastructure development as a goal, with the deeper intent to build support from parents and surrounding communities for technology-supported learning environments. The result improved access to technology both for students in the three districts and for parents who gained access to new parent centers.

The program connected 10 partner schools, a teacher preparation institution, and the parent centers to one another and the Internet to support lifelong learning for all participants. Train-the-trainer professional development provided mentor teachers to train and collaborate with their peers, both face-to-face and using tools supported by the technology infrastructure, such as e-mail and listservs. Parents benefited from classes in basic technology skills, citizenship, English as a Second Language, and parenting skills. A positive side effect of greater awareness was parents' increased participation in the education process. They became more vocal about their support for technology in schools and more likely to purchase computers for home use.

The program provided a valuable lesson about developing assessments to evaluate the impact of technology. Early evaluations shifted from quantitative data that relied on counting—the number of computers, the number of teachers in the program, the number of graduates from graduate programs—to qualitative data that gathered participants' perceptions. Evaluators began to ask if teachers were satisfied with the program and why. The third evaluation stage turned to collecting outcome indicators, such as the impact on student achievement and engagement, and changes in teacher pedagogy. This progression of evaluation procedures paralleled the progression of teacher technology adoption as documented by the ACOT™ studies. This seemed to confirm that schools and districts progress through stages, too, and that level of technology integration should be considered when evaluating impact.

Making Connections

Projects that illustrate how educators have used connectivity to enhance learning are described here under three headings: spanning distance with technology, creating learning communities, and using Web resources. Some projects could fit in any of the categories, so are placed where they are most helpful in illustrating particular points.

Projects that span distance with technology provide some form of distance education. Some offer online courses to high school students or to teachers who want to earn college or university credit; others use technology to collaborate across distance in the development of curriculum and in managing a project.

Projects that use technology to create learning communities link people electronically to accomplish shared goals. Effective partnerships require regular and effective communication, but learning communities add joint problem solving. Accordingly, projects that focus on creating learning communities are distinct from projects that use technology for communication. They involve parents and/or local businesses in the actual learning activities of children. An example might be business leaders mentoring students via e-mail.

Projects that enhance learning through the use of Web resources create or provide information via Web sites.

Making Connections: Spanning Distance with Technology

Distance education now appears on the list of education buzz words. Virtual high schools are being added to the education portfolios of many states; colleges and universities are moving quickly to compete with businesses that offer training and development via distance-education technology. Issues of accreditation, quality control, and territory confront the distance-education movement, but this is clearly a use of technology that has rapidly gained widespread acceptance. Other distance-spanning technology uses have been embraced even more quickly. For example, many families now stay in touch via e-mail and many businesses now use videoconferencing.

The Virtual High School, 1996

Hudson Public Schools, Hudson, MA
www.govhs.org

The great and growing interest in online high school courses led Virtual High School to attempt to create a national collaborative of schools that offer courses over the Internet. Each semester of the past year, 250 participating schools offered 150 courses to approximately 3,000 students in 22 states and 7 countries through Virtual High School (VHS). Student enrollment has grown phenomenally over the life of the project. At inception, there were only 28 participating schools. The professional development course for teachers who want to teach online is expected to enroll 100 new teachers annually.

Many U.S. schools have found it difficult to offer all the courses they would like to make available to students, especially schools in isolated rural areas or where the need for advanced and highly specialized courses is sporadic. Virtual High School has taken the lead in responding to this need by pooling online courses from various school systems around the country, demonstrating how technology can provide a win-win situation for schools and students alike.

The vision for such an undertaking was deceptively simple. Suppose Patriot High School offered a physics course and American High School offered an advanced course in German. Patriot had students who wanted to enroll in German so it offered a trade: Patriot students could enroll in the American course and in return the American students could enroll in the Patriot course. Each school used a groupware package to structure and support everything from posting a syllabus and listing assignments to providing a chat room for real-time discussions and enabling students to counsel with the teacher individually.

Though it sounded easy, there were myriad details to be worked out. Think of something as simple as class scheduling—Patriot courses started on the hour and American courses started on the half hour, for example—and then add issues such as compatibility of hardware and software, having a server that is robust enough to host the course materials, dealing with connectivity, and meshing curricula across two schools, and the scope of the problems begins to emerge.

Now add dozens more schools and hundreds more students, and the complications spiral geometrically. This was an administrative nightmare that no single school or system could tackle on its own. Costs and benefits just wouldn't balance if two or three schools invested what it takes to develop a first-rate virtual high school. Clearly this kind of challenge required collaboration. VHS and its partners pioneered administrative and technical systems that made this arrangement work effectively.

The primary goals of VHS revolved around creating and implementing online courses to demonstrate that such an approach was feasible while maintaining high standards and providing quality learning experiences for students. An important related goal was providing training for teachers who were interested in developing and teaching online courses.

VHS accomplished these goals through building a three-part infrastructure. Project staff elected to use NetCourse, a software system to support online course delivery; Lotus Learning Space, a 26-week training program to help teachers put their courses into a format suitable for online instruction; and a management and administrative system that could effectively anticipate and address the many logistical and policy questions.

The Hudson Public Schools served as the local education agency that applied for and received the Challenge Grant in 1996. The Concord Consortium (www.concord.org), a nonprofit research and development organization dedicated to a revolution in education through the use of information technologies, was a key player, as were several corporate partners. Lotus Development Corporation created the groupware to support VHS courses and teacher training. Other partners included Interliant, Compaq, American Power Conversion, and 3Com, each of which contributed in various ways to provide and maintain the equipment and technical support needed to keep VHS operational.

Fitchburg State College played a key role in providing graduate credit for NetCourse, the professional development central to achieving and maintaining quality learning experiences in the online courses.

The collaborative aspects of VHS were fundamental to making it functional. Each semester of participation allowed a high school to enroll up to 20 students in VHS courses. In return, the high school receiving the instruction furnished a teacher and course to students in the network. For high schools not ready or able to get that involved, a one-year "student-only" membership allowed 10 students per semester to enroll in VHS courses without offering a course in return.

Participation in VHS involved several costs. Teacher tuition for NetCourse training ranged from $1,500 to $6,000. The annual membership fee of $1,500 included the cost of training a local site coordinator for the school. Unlike some virtual high schools that required students to have their own computers, VHS expected participating schools to make computers available on the home campus.

Visit the VHS Web site to gain a full appreciation for all that is involved keeping students and teachers informed and up-to-date. Clear, concise information on student and faculty feedback, project evaluation, and more is provided. Demonstration courses in English literature and composition are accessible to visitors, but most course information is limited to registered users who have passwords.

VHS courses involve extensive independent study and are accredited through the originating school. Courses cover a broad array of topics, including mythology, bioethics, photography, chemistry, and mathematics; are available at all hours; and open to students in grades 9 to 12.

Technology is fundamental to VHS. Students learn to use the Internet for communication as well as for gathering information from a vast array of sources, including experts who can be contacted online. While students do have opportunities to collaborate using e-mail and chat rooms, they must be capable of working independently, which demands dedication and self-discipline. Online learning may not be for everyone.

In the first three years, annual evaluations focused primarily on how well the project infrastructure was working. Feedback was encouraging and useful in identifying needed changes. In 2000-01, evaluators reviewed student performance by comparing face-to-face and online versions of the same courses. Findings showed.that, generally, VHS provided high-quality courses taught by high-quality faculty to students who would not otherwise have opportunities to enroll. Students earned essentially the same grades and learned the same information. Specific findings indicated where improvements could be made. Some concerns were identified:

- Student-to-student interaction and group work were less common in VHS courses.
- Online teacher-student interactions were rated less positively than face-to-face ones.
- VHS technology presented some significant limitations for visual (graphics-related) and hands-on courses.

The schools served by VHS have been quite diverse. Geographically, they have ranged from rural and remote communities in Washington and Colorado to more urban schools in the Research Triangle area of North Carolina and the technology beltway communities of Massachusetts and California. Half of the participating high schools (51 percent) had enrollments of less than 800 and most (84 percent) had enrollments of less than 1,500. Participating schools covered all levels of the economic spectrum, with per-student expenditures ranging from $3,483 to $15,175.

VHS, Inc. now operates as an independent nonprofit, as TICG funding ended in September 2001. This addresses one of the important expectations for Challenge Grant projects, which is to sustain project activities beyond the life of the grant.

Cascade Consortium, 1997

Manson School District 19, WA
www.cc5.org

By banding together, five districts known as the Cascade Consortium gained support to develop a high-bandwidth video system of superior quality. Their sophisticated telecommunications system demonstrates how distance education can effectively overcome the geographic barriers created by mountain ranges and severe winter weather. An interim report, available on the Web site, described in nontechnical terms how MPEG (high bandwidth) was interfaced with IP (Internet Protocol) to create high-quality visual and audio connections broadcast by satellite technology. Using this system, all community members in the Cascade Consortium have benefited in many different ways.

For example, working closely with the University of Washington in Seattle, the Cascade Consortium arranged to have teachers enroll in two online professional development courses: Using the Internet for Curriculum Development and Integrating Technology for the Development of Reading Skills. Teachers could participate in many other online professional development activities, including meetings devoted to curriculum development and instructional planning. Distance education filled a true need in north central Washington.

The Cascade Consortium area has been described as socially, economically, and culturally disadvantaged. Separated from the more-populated Pacific coast by the Cascade Mountains and dependent on two seasonal industries (tourism and agriculture), the area is isolated from universities and other sources of expertise. The Consortium serves 3,627 K-12 students who are spread over some 3,500 square miles. Nearly 70 percent of these students qualify for free or reduced-price meals.

The Cascade project's five goals were to

- improve academic achievement
- expand educational opportunities
- challenge nontraditional students
- provide high quality staff development
- promote community lifelong learning

The Consortium used its broadband system to offer advanced and specialized high school courses that could not be offered otherwise. For example, Pre-Calculus, Calculus, Spanish III, and Sociology/Psychology were offered. The system supported other interactive activities such as student meetings, teacher projects, and special events coordination. For example,

students have planned dances and developed community calendars. Preservice teachers who will student-teach in Consortium schools have been able to start the orientation process online, even meeting the children in their classrooms. Distance education programs for students with special needs have included a shared reading program for deaf students provided by the School for the Deaf and Blind in Vancouver, BC.

Schools in the Cascade Consortium developed a program to adapt the school calendar to the needs of children of migrant families, who return to their homes in Michoacan de Ocampo between mid-December and the end of January. An online learning center made available eight modules in various subjects, including language arts, Washington state history, U.S. history, physical science, and English as a second language. Some migrant families could borrow computers from the project to take to Mexico to facilitate online instruction. Other migrant children used "cybercafé" connections in their Mexican communities to keep up with classroom activities in Washington state.

Other community members benefited from the distance education technology by enrolling in continuing education classes. Free lifelong learning and continuing education courses have included Basic Computer Operations, Basic Word Processing, Basic Internet, "Tech Toys" Basics, and Traveling Online. Language courses have been offered online for migrant workers who want to improve their English skills.

A special multi-(uni)casting system made it possible to send multiple video and audio signals to all locations. In other words, people at one site could see and hear people at every other site during a class or meeting. This could improve the interactions among participants and be especially useful for teachers to detect facial expressions, body language, and other nonverbal cues in order to make adjustments and accommodations.

Partners in the Cascade Consortium included Verizon, Optivision, U.S. Electrodynamics, iMatrix, GTE, the University of Washington, and several federal programs, such as the STAR Schools project and PT3 (Preparing Teachers to Teach Technology).

A host of lessons learned range from advice on camera angles to how to coordinate broadcast schedules across sites. Because many were procedural in nature, the interim report constituted a "handbook" of sorts (www.cc5.org/2000Html/2000interim.pdf).

Progress was made on all five goals. Scores improved on standardized achievement tests, although project staff wouldn't claim these as directly attributable to distance learning technology. Educational opportunities increased substantially, although several advanced courses were slow to be developed. Cascade Consortium schools turned to the Virtual High School project for assistance in addressing this need. The goal of serving nontraditional students has produced mixed results. The program for migrant children has begun; efforts to provide extra support for deaf children

worked well. The online professional development activities have been especially effective; they have helped teachers meet state recertification requirements and had a noticeable effect on how teachers use technology for instruction. Community and lifelong learning activities have successfully addressed an important need in these isolated rural communities.

Other Projects: Virtual High School or Distance Education

The Electronic School, 1996
Hawaii State Department of Education, HI
www.eschool.k12.hi.us

One advantage of online education is its ability to provide flexible course choice and attendance options to students, but E-School carried the theme of flexibility through to its basic operations and management. The program developers were flexible right from the start when they dropped original plans for dissemination over television and other technologies and focused strictly on Web delivery. This helped them to reach all schools across the island state and was particularly effective in isolated rural areas outside of Honolulu.

Key to program success was the incorporation of formative evaluation methods that quickly impacted course development and delivery, instructional strategies, and student success. E-School experienced an early drop-out rate of 57 percent. However, higher drop-out rates are common for Internet-based courses. Formative evaluation data led to the development of Cool Talk, a course to prepare students for the rigor of this type of study. E-School also added two part-time teachers to support site facilitators and to counsel students. These strategies, along with personal visits, phone calls, and e-mails, helped to reduce the drop-out rate to an admirable 12 percent. E-School has grown to include more than 20 courses, several full-time teachers, alternative funding sources that should ensure sustainability, and guidance for course developers and teachers. The program's flexibility helped it to evolve into a viable learning alternative for all students in the state.

PASS Internet Program: Cyber High, 1997
Fresno County Schools, CA
www.cyberhigh.fcoe.k12.ca.us

Fresno addressed the problems associated with helping students of migrant workers succeed in school by pairing the curriculum of the California Portable Assisted Study Sequence (PASS) program with networked technologies. A variety of technology-supported media, tracking, and

assessment and feedback mechanisms built on the more than 40 standards-based PASS courses, all of which were made available for Internet delivery through Fresno County's Cyber High.

As students in grades 9 through 12 moved around the state with their families, they could access curricular units from libraries and community centers in order to meet graduation requirements. Graduates who used the technology-supported system said they felt a greater sense of empowerment and built valuable technology skills demanded by a high-tech economy.

New Vision, 1995
Towanda Area School District, PA

The dizzying pace of technology change can be overwhelming and may cause some school districts to simply avoid purchasing new tools. Others find a successful compromise by using common technologies in new ways. That was the approach of the Towanda District's far-reaching New Vision program and its Partners in Distance Learning (PDL) consortium. This project utilized interactive compressed video to pair classrooms across the state. Originally targeted at improving access to resources for rural schools, New Vision blossomed to support more than 300 schools in many settings—approximately 30 percent of all state schools.

Using a system developed by Picture Tel, teachers and students linked to document cameras and fax machines could "join" across a distance. As many as seven classrooms could collaborate at the same time through this bridging process. In addition to enabling schools to share resources with other schools, the network grew to include partner museums and science centers. In one year, more than 10,000 students in Pennsylvania took virtual field trips to visit legislators, scientists, and other content experts. Some interesting early feedback indicated that students at distant locations seemed to outperform their peers at the home site, and that video images were often more engaging and compelling to elementary students.

New Vision made some wise strategic choices in terms of funding and deployment. The state and major vendors contributed money and equipment to the system. In addition, the system instituted a minimal $250 membership fee for schools. This revenue added resources to the system; schools gained the benefits of "shared" staff. The distributed model also released any one school or district from the liability of owning and supporting the network and encouraged individual schools to generate and nurture their own relationships.

IN-VISION, 1997
Educational Service Unit #5, NE
http://invision.esu3.org

While the Internet has helped to reduce global barriers, many people lack the language skills to collaborate outside the English-speaking world. IN-VISION capitalized on human and technology resources to help teachers and students in 14 schools build proficiency in speaking, reading, and writing Spanish while strengthening ties across the globe.

The program brought native Spanish speakers into classrooms both in person and electronically through videoconferencing and Web-based communication tools. Teachers in the program learned both Spanish and methods for integrating technology into their classrooms. The language and technology modeling of teachers had widespread impact on students; it prepared them to use technology for a variety of learning tasks and to become aware of other cultures. The project has created several products, including a K-8 idea book for Spanish lessons, a resource book, K-6 lesson plans that integrate Spanish, suggested technology integration strategies, and manuals for staff development and training.

The Learning Cooperative, 1995
Indianapolis Public Schools, IN
www.thelearningcooperative.net

Bridging the differences among three diverse school districts posed challenges for this project. Efforts were made to build relationships among teachers and to create a unique professional development model that would lead to technology integration, particularly in the curricular areas of math and science. The original plan focused on giving teachers opportunities to first play, then experiment, with instructional ideas for integrating technology into classroom practice. Group reflection and responses to experimentation were planned. Interested teachers received training in the use of graphing calculators, scanners, presentation software, and a database program. Some teachers formed interest groups that worked to develop units for classroom use. Focus moved from the use of technology as an event toward uses of technology that are more transparent.

Making Connections: Creating Learning Communities

Sociologist Robert Putnam, author of *Bowling Alone,* marshals some revealing statistics to support a belief that Americans are more insulated and isolated from one another than at any previous time. People do less voluntary work for charitable organizations and political parties, spend less time in civic organizations, attend church less often, and join fewer social clubs, to cite a few of the findings Putnam presents. Telecommunications technologies—cell phones, e-mail, the Internet, and handheld communication devices—certainly have potential to help people reconnect. That was the main premise of one Challenge Grant project.

Project LemonLINK: The Connected Learning Community, 1997

Lemon Grove School District, CA
www.lgsd.k12.ca.us/lemonlink

This community eight miles east of San Diego is slowly being absorbed by urban development. A diverse community, its older sections survive from an earlier era, and newer sections have sprung up in response to out-migration from the city. Overall, Lemon Grove has a high minority, low-income population, with more than half of its children qualifying for free or reduced-price meals.

The LemonLINK project addressed several goals aimed at creating ways for people in the community to connect via technology. One was a community intranet that could be used by students, parents, and community members. The school district contracted with the local cable TV provider for the intranet, which operates with high-speed Internet access via dedicated fiber-optic cable modems between the local education agency and the cable company.

The leadership group saw helping students learn to use technology as preparation for the information age and believed technology could improve the achievement of children in basic skills.

A partnership of telecommunications and software firms, local government, and local businesses cooperated with the school system to create and maintain the infrastructure and to extend the network into community homes and government agencies using wireless microwave links to the school intranet. Wyse Technology worked with the district to build an affordable home computing device that would not require costly mainte-

nance or software upgrades. Cox Communications made high-speed cable modems available at a discounted rate so home computer users could get homework assignments online and communicate by e-mail. Information resources were provided so students and parents could find current and archived periodicals and newspapers.

One step toward accomplishing the goal of connectedness was to improve the student-to-computer ratio in each of the eight Lemon Grove K-8 schools. LemonLINK doubled the number of students who have access to computers by converting old computers to less expensive, easier-to-maintain network appliances. Each K-3 classroom received three computers and eight network appliances, and grades 4-8 got four computers and 12 network appliances per classroom.

The project provided teacher professional development on effectively integrating technology into classroom activities and using the network to share information with parents and interested members of the community. Twenty percent of the teaching staff were scheduled to participate each year so that all teachers could receive more than 120 hours of ongoing training.

The availability of technology enabled teachers to improve classroom management with computerized systems for recording grades and reporting attendance. They integrated Web-based instructional units and Web-searching activities into their teaching. Teaching resources include integrated software for communication, production, and research. Gains on standardized achievement test scores, especially in math and reading for grades 3 to 6, caused Lemon Grove educators to believe technology made an important difference in student learning.

LemonLINK accomplishments include recognition for leadership in making computer applications to learning. Among the awards received are the Ohana Leadership in Technology Award, the Smithsonian Computerworld Award from the Museum of American History, the *American School Board Journal's* Magna 2000 Award, the American Association of School Administrators Promising Practices Award, and *Business Week's* Smart Links Award. In addition, the *Wall Street Journal* featured LemonLINK in an article lauding its use of thin client devices to run new and fast programs off a Web-based server. Read more about LemonLINK's many honors at www.lgsd.k12.ca.us/lemonlink/PressPacket.htm.

WEB Project: Creating a Web of Evidence of Student Performance, 1995

Montpelier School District, VT
www.webproject.org

Beyond its intriguing title, this project had considerable depth and substance and defied easy categorization. Although it appears among projects that illustrate the development of learning communities, it had many other facets.

WEB Project set out to improve student learning through the use of multimedia and telecommunications. It wasn't unique in deciding to establish an online learning community but broke new ground when it decided to engage students, teachers, and mentor-experts from the "real world" in an ongoing electronic dialogue focused on student learning. The Internet became a vehicle for discussions around products developed by students.

Project staff targeted an unusual content area—music composition in the elementary schools—and tackled a difficult technical problem—sharing music compositions online—before multimedia software had evolved to make online exchanges of artistic products relatively simple. Initially staff devoted time and energy to finding software that could support the types of online conversations the project required (information exchanges, online dialogues, and design conversations). This involved arranging for special programming and consulting with Web developers. As the Web matured, technical solutions caught up with project needs.

WEB Project wanted a network of people who were willing to be personally involved in helping students grow and learn in an area not often associated with technology—the performing arts. Challenges to meeting this ambitious goal included finding the means to distribute equipment that could meet the demands of the project concept, creating a professional development program for teachers, providing the necessary technical support, establishing vehicles for online dialogue, finding a way to post student compositions (and eventually other student products) online, facilitating critiques of student work, and exploring technology's potential for enhancing student performance. Some needs could be anticipated, but others emerged as participants felt their way along, such as figuring out how to use technology to support student mentoring.

Initially three school districts collaborated with several partners, including the Vermont Alliance for Arts Education and the Vermont Historical Society. Nine more school districts and the Vermont Center for the Book; the Vermont Institute of Science, Math, and Technology; and the Vermont Department of Education soon came on board. The Vermont higher education system and various businesses also played active roles in the project.

Eventually 15,000 students in 64 school districts gained access to online resources through WEB Project.

New organizations grew out of the early online interactions between students and mentors. Content specialists and professional organizations formed the Vermont MIDI (Musical Instrument Digital Interface, www.vtmidi .org) project and ARTT (Art Responding Through Technology, www.vtart .org). Teachers who mentored MIDI (music) and ARTT (visual arts) projects customized the system to fit individual needs. Some teachers used the system to work with students individually (as in digitizing and posting their work in progress), while other teachers worked with groups and focused on activities that asked meaningful questions about student work while building art vocabulary and critique skills.

An important part of the project was improving student learning while creating the "web of evidence" alluded to in the project title. This involved critiquing and otherwise assessing student performance in fields where answers to questions about subject matter are either not relevant or are open-ended and not easily reduced to so-called "objective measures." Early efforts focused on identifying and establishing the right conditions for effective learning. Formats for assessing student work were left until after the learning activities had been successfully launched.

After the first year the project expanded into other areas, including infusing technology into learning in specific content areas (fine arts and the soft sciences). WEB Project work was tied to Vermont's content and performance standards, which provided the framework for professional development and instructional design. Teachers collaborated to develop strategies for addressing standards in their content areas and in technology. These efforts resulted in high success rates for students, who also seemed to be more engaged in learning, more self-directed, more motivated to learn, and more adept in using metacognitive processes.

The WEB Project contributed to the development of an online reporting system for information about schools and communities. Utilizing GIS (Geographic Information System), a graphic map of Vermont was created that enables users to find state-level and local information, such as information about food stamp distribution and special education services. GIS is used to report the distribution of technology across the state. It also offers rubrics for scoring the level of discussion about student work, and links schools to relevant external databases about school performance.

The project had several sustainable outcomes. Chief among them:

- creation of student products
- student and teacher acquisition of technology skills
- student acquisition of content area knowledge
- student motivation to learn

- creation of a new paradigm for learning communities
- advancement of knowledge about online conversation
- changed teacher practices
- validation and advancement of theories about technology innovation, adoption, and diffusion
- substantial contribution to knowledge of effective practice for conducting online dialogue

According to evaluation reports, WEB Project faced several challenges:

- Intellectual property issues: The WEB Project created several innovative strategies and models for its work; issues of intellectual property occasionally surfaced and had to be resolved.
- Time: As with most education reform initiatives, the WEB Project experienced challenges with helping teachers find time for professional development, online dialogue, planning, and practice.
- Access to technology: At several schools, lack of reliable access to technology tended to cause problems.
- Administrator turnover or lack of understanding: The WEB Project relied on district- and building-level support for the teachers who participated. However, in some sites, administrators changed every year, resulting in discontinuity and requiring extra effort to shape a supportive environment. Often, when a leader who understood and supported the project left, the new leader did not buy into the vision and wanted to put his/her own vision for technology use in its place.

Lessons have been learned. The project demonstrated that online collaboration could support learning, but educators felt constant pressure to let technology take over and dictate the learning process. These words from the project evaluation captured the idea well: "Stay with the vision. Emphasize the computer as an expressive tool for communication. Concentrate on what actually happens for fine arts students in the classroom. Embed reflection and critique 'as a natural part of what to do' into the creative processes that teachers and students employ."

WEB Project was among more than 135 nominees reviewed by a U.S. Department of Education panel of experts. In September 2000, after a two-year search, the panel selected WEB Project as one of five judged to be most promising.

Now a nonprofit organization, WEB Project continues to pursue its vision. Online mentoring is being adapted to community-based learning, preservice education, and professional growth for teachers in other content areas.

The New Spectrum Learning Program (NSLP), 1997

Los Angeles Unified School District, CA
www.workforcela.org/nslp.htm

The New Spectrum Learning Program aimed to build and share new knowledge about deploying emerging technologies in education settings. NSLP was based on the premise that students are knowledge generators. From this premise the project staff went on to conclude that teachers must be knowledge workers.

The main objectives were to

- establish and refine a community of teacher-learners
- formulate a New Media Academy within the Los Angeles public schools
- provide distance education opportunities for low-income children
- link learning experiences to the outside world

New Spectrum pursued its goals in partnership with several organizations and institutions including Workforce LA, the Los Angeles Unified School District, the California Department of Education, the Entertainment Industry Development Corporation, the City of Los Angeles, DreamWorks SKG, and Claremont Graduate University.

NLSP professional development was intended to build learning communities using a student inquiry approach. Teachers learned to use specific steps in their work with students by using the following modes of inquiry:

- asking what's the big idea
- looking for evidence
- engaging in social discourse
- finding validation
- revising based on information

The NSLP learning community included high school art students in selected schools in Los Angeles, their teachers, and volunteer artists from the entertainment world. Members used technology and distance education strategies to combine the study of art with business-related applications in the entertainment world (animation).

New Media Academies (NMA) and ACME Virtual Training Network (VTN) played key roles in NSLP. The academies were akin to schools-within-schools—program units focused on art within the high schools. They were located in nine high schools in greater Los Angeles—chosen because they

served high percentages of needy students. The schools also agreed to participate in ACME VTN. NSLP renovated unused high school shops, turning them into modern, media-rich "collaboratories" for teaching the NMA art courses. Students enrolled at their home schools.

The ACME VTN distance education initiative, operated under the auspices of Workforce LA, was already running a pilot program when NSLP received funding. The program connected professionals in the animation industry with underserved art students in selected high schools (as well as colleges and adult education programs around the country). The ACME leadership team agreed to join NSLP to provide structured professional development for NMA teachers. ACME VTN was especially interested in extending the NSLP approach to other curricular areas.

ACME VTN gave students and teachers a hands-on opportunity to learn from professional animators at Warner Brothers Feature Animation, who were chosen for their teaching ability. Graduates were qualified for employment in the entertainment business. Technology enabled classrooms to be interactive and to build on student performance as they experimented with digital and video systems. Classes met each week in two-hour sessions and were linked via multipoint videoconferencing.

The professional animators led NMA classes through lessons that progressed from basic drawing and animation exercises to challenging animation techniques. Time was taken to explore questions and critique student work. The classroom teacher observed the video-based classes and followed up in regular class sessions as students did assignments between online sessions. The teacher's role changed from disseminator of information to facilitator for student success, reconciling learners' goals with real-world applications.

Through participation in the professional development activities as well as ACME VTN, classroom teachers in the NSLP learning community learned to approach subject matter as exploration and use technology to link content to the real world. Monthly development sessions were forums for teachers to discuss how to better serve students. They helped teachers gauge their own progress by reflecting on student work and presenting ideas to one another.

Applying distance learning technology in this way—to bring industry professionals and classroom teachers together to discuss pedagogy and meet real-world standards—reflects the central idea of the Technology Innovation Challenge Grant program.

Other Projects: Learning Communities

The New Spectrum learning community shares some features with other projects—such as the way artists mentor students using the Internet, much like what happens in WEB Project—and adds its own distinctive approach. Other Challenge Grant projects have developed other takes on learning communities.

Extending Learning Through Community and Family, 1997
Sumter County School District Two, SC
www.myschoolonline.com/sc/sumter2

The Extending Learning project promoted communication and technology integration across the greater Sumter area. The project connected schools, local businesses and industry, community organizations, government agencies, institutions of higher education, the library system, health care providers, and parents and community members by creating a "virtual" community. Lines of communication were opened by installing phones in classrooms and establishing a network of student and family access centers where visitors had free access to computers, printers, modems, e-mail accounts, and the Internet. These centers also allowed students to continue schoolwork outside of class time.

Beyond providing access, the schools focused on training teachers to create curriculum materials and to better integrate technology into their classrooms. Teachers used standards-based, technology-supported curriculum materials. Administrators used a project-developed observation site to document technology use in schools and to gather evaluation data to measure impact of the project.

Learning Community 2000, 1996
Pekin Public School District #108, IL
www.pekin.net/pekin108/lc2000

Pekin Public School District broadened the concept of infrastructure to include organizational structure, widespread access for the community, training, and models to promote discourse on the Web. The result was Learning Community 2000. Rather than simply connecting computers at each school to the Internet, Pekin considered the impact connectivity might have on the broader community and sought to become a major influence in the way citizens used the Internet in their community.

The physical infrastructure was supported by technology training for teachers and community members through a "TECH Academy" offering up to 80 low-cost courses a year at schools, libraries, and senior centers. Education majors at Illinois State University benefited from the Learning Commu-

nity 2000 Professional Development School, where they completed methods courses and student teaching in Pekin's classrooms.

To disseminate findings and work beyond the school community, Learning Community 2000 helped to develop the Web-based learning resource called Congress Link, a comprehensive guide to Congress updated and maintained by the Dirksen Congressional Research Center. Pekin project results appeared on other Web pages where students joined Web development teams for civic and business groups.

The Education Connection, 1996
Norfolk Public Schools, VA
www.educonnect.org

The Education Connection leveraged the knowledge of telecommunications experts in public broadcasting to build a consortium of 31 at-risk schools and six public broadcasting providers from five regions in the Mid-Atlantic and Southern states. From this diversity of experience, the Education Connection developed media related to technology integration in the classroom for dissemination across multiple media. Two examples were an environmental education program called Trash Bash and an economics course for middle school students called Economics Online.

Perhaps the best example of this amalgamation of multiple media was NetFiles, a monthly television program for teachers focused on integrating Internet resources. The companion Web site included collateral materials for NetFiles videos, such as lesson plans, and streaming video of some NetFiles programs. The site also offered an "ask an expert" feature and advice on a Web site construction and Internet safety.

Teaching & Learning with Technology: Bridging Schools & Home with Technology, 1996
Lawrence Public Schools, MA

The Lawrence Public Schools centered on strengthening the link between school and home by providing technology-supported tools and training to teachers and parents. Undaunted by an influx of immigrant families—whose primary language often was not English—Lawrence successfully employed technology to build supportive partnerships to increase access and technology skills throughout the community.

The program partners included schools beyond Lawrence, each of whom provided expertise and support. The Northern Essex Community College first got involved by providing a four-week summer program for students in grades 3 through 8. The "College Academy" focused on building technology skills and providing enrichment activities. Its success led to the develop-

ment of more activities for students and their families, and using the campus after school, on weekends, and in the summer.

The WGBH Teacher Center provided professional development during the summer and ongoing classroom support throughout the year. The Seton Asian Center provided access to technology for large segments of the community and showed the value of building partnerships that reflect the community. Other partners included MediaOne and Valley Communications Network, which provided Internet and Web development services; the Lawrence Public Library; and the Merrimack Valley Regional Employment Board.

Chicago Neighborhood Learning Network (CNLN), 1997
Chicago Public Schools, IL
www.edc.org/ewit/cnln

Formative evaluation helped the Chicago Neighborhood Learning Network succeed. Many schools and districts focus on networking and hardware when implementing a technology plan; however, data from CNLN's formative evaluation helped the project team think more holistically. The project goals focused on systemic impact that would extend from school-age children to all citizens. Project partners included public and Catholic schools, technology learning centers, public housing, a city college, and a center for senior citizens.

Technology access was developed in this urban setting, often in places where none had existed before, but the access required components beyond "wires and boxes" to realize benefits. Professional development was key to integrating technology in the classroom. Workshops and outreach efforts helped community members build technology skills and address relevant community issues such as immigration and citizenship, local and city services, and parenting skills. The project demonstrated the importance of using data to evaluate project goals and to redirect project strategies to better suit the needs of recipients.

Technology in Education Challenge for Rural America (TEC-RAM), 1995
Black Hills Special Services Cooperative, SD
www.tecram.tie.net

The TEC-RAM project staff envisioned using technology to drive school reform by supporting learning "everywhere." The project's extensive support within the state legislature enabled it to capitalize on state initiatives, such as the governor's Technology Training for Teachers program. In this mutually beneficial partnership, project staff returned expertise for support.

An early stumbling block for TEC-RAM was the lack of state standards. The project staff sat down and developed standards, which the state then used as a model. The Internet was the project's main vehicle for instruc-

tional support and communication. Students have used the Internet to send e-mail, participate in chat sessions, and develop virtual tours of their schools. Teachers used it to share lesson plans and to send and receive project information.

Baltimore Learning Community (BLC), 1995
Baltimore City Public Schools, MD
www.learn.umd.edu

The Baltimore Learning Community successfully promoted technology integration by providing products and services to support teachers. This partnership among the Baltimore City Public School System, Johns Hopkins University, the University of Maryland at College Park, and Discovery Communications, Inc. had its greatest impact with middle school teachers by providing software, videos, and Web-based applications that support teaching and learning.

One successful product that evolved from the project was an online tool for teachers to create and share lesson plans and associated activities. Initially, this tool was for use only within the project, but there were plans for widespread dissemination. In addition, a digital library of audio, video, image, text, and Web resources indexed by subject, grade, learning objectives, and national standards was available to project teachers. With this strong groundwork of products in place, project focus shifted toward teacher training. Results showed teachers more often using technology to teach, collaborate, contribute to the growth of the electronic community, and develop leadership skills within their schools.

Delaware Interactive Educational Television Consortium, 1995
Capital School District, DE
www.challenge.k12.de.us

The Delaware Interactive Educational Television Consortium sought to extend the amount of time students spent on learning activities by formally extending learning into the home. The project used educational CDs developed by Lightspan both at home and in elementary classrooms. While teachers used the CDs on school computers, students received free Sony PlayStations to take home. Started in the Capital School District, the program spread to more than 35 schools across the state.

The project found changes in both teacher practice and student home behavior. Teachers used the CDs in class and were more likely to use the Internet for instruction at least one day per week. Students used the software for 30 minutes or more. At home, students in the project tended to watch less television and spent more time on schoolwork and learning activities. Project schools also noted increased parent involvement, as parents had to visit the school to receive the free hardware and to be trained for its use at home.

Making Connections: Using Web Resources

The value of technology to support and expand learning opportunities is nowhere more evident than in the information superhighway known as the World Wide Web. Web resources can help the teacher or student who is learning to use computers and can be incorporated into lessons. One TICG project developed a resource to create interest in and provide information about science, history, culture, and the environment. Students and teachers alike find NatureShift! fascinating.

NatureShift! Linking Learning to Life, 1997

Grand Forks Public School District #1, ND
www.natureshift.org

The NatureShift! Web site invites exploration and offers support for nearly any approach to learning. Colorful graphics, engaging animation, and sound effects virtually pull the user into the content. Customized paths lead to age- and role-appropriate destinations.

This description from the Web site gives an overview:

> The NatureShift! Model is a multidimensional knowledge quest, based loosely upon Bernie Dodge's Web Quest. Expanded to incorporate free-choice education methods, specifically learner-initiated inquiry, exploratory investigation, hands-on activities, and project-based assessment.

The site supports an inquiry-based approach to learning, yet much of the content presented in its five modules is keyed to national curriculum standards. Each module features different content.

- *Wounded Hawk* explores science history through a cultural lens. It is built around the Sahnish Native American nation and includes maps, music, dance traditions, art, and food.
- *Memories and Stories* presents North Dakota studies and history, including the heritage of the state's Native American nations.
- *Robot Lab* introduces engineering and physical sciences through seven topics—energy, gravity, magnetics, motion, matter, telerobotics, and technology.

- *Ranger Rosie* uses an eco-mystery to look at a wetlands environment.
- *Dakota Skies* invites explorers to learn about weather, astronomy, and space studies.

Each module provides opportunities for interactive participation. An "exploration project" introduces a problem to be solved through information that is provided. Students have personal storage spaces online for collecting and processing the information they gather. Links to relevant Web sites are also included.

The NatureShift! learning model has four core components, akin to steps toward developing understanding. The first component, *Engagement,* arouses the learner's curiosity. The second, *Web Adventure,* routes learners to preselected, Web-based resources. The third, called *Real World Adventure,* involves making connections through hands-on experiments in the real world. The fourth, *Exploration Project,* has users develop a product that displays or explains what has been learned. The product might ask users to use technology to create a Web page or to develop a 3-D model or an exhibit.

The clever design of the site makes help readily available. One icon takes users to a page where tutorials are offered for transferring files (FTPs), constructing Web pages, making a QuickTime Virtual Reality using panoramas and objects, manipulating images, and using Kid Pix to make name badges. One area offers technology tips for using digital cameras, scanning images, and using a MiniDisk recorder.

NatureShift! includes advice on several topics but has no professional development component. Educators are encouraged to develop higher-order thinking skills and to integrate technology into instruction but don't receive information on theory or research.

Partners in the NatureShift! project include universities, public schools, museums, parks, and libraries. NatureShift! is directed by the chief administrator of the Dakota Science Center (www.dakota-science.org). According to its mission statement, the Center seeks "to promote lifelong curiosity and fascination with all sciences in youth, families, teachers and the community through discovery, exploration and interaction." There can be no doubt that NatureShift! effectively supports this mission. The Grand Forks Public School System serves as fiscal agent for the project, and several system schools act as pilot sites for NatureShift!

Project WhistleStop, 1996

Independence School District, MO
www.whistlestop.org

At first blush this project appeared to be devoted primarily to putting the Truman Presidential Library online. Certainly a central component of WhistleStop was the Web site that provides primary source materials previously available only through the Truman Library. However, the project's broader scope involved professional development for teachers as well as outreach to teachers across the state.

Because of WhistleStop, what once required a trip to Independence became possible from a distance. Anyone interested in learning more about the administration of President Harry S. Truman and the functions of government could access an enormous database of documents generated during Truman's life. In fact, the site incorporated more than 12,000 pages of primary source materials, such as letters, memos, cartoons, photos, and the like.

Teachers benefited from being linked to the Missouri State Education Agency Web site where they could access lesson plans and instructional activities developed and posted by fellow teachers. Lesson plans were grouped by grade level (elementary, middle, and high school); aligned with state standards for social studies, communication arts, and fine arts; and focused on government and the presidency, and on the life and times of President Truman.

Professional development was offered in cooperation with the Center for Technology Innovations in Education, University of Missouri-Columbia. The program included a series of workshops and conferences and provided graduate credit. Teachers received training on how to involve students in research using classroom as well as online resources and learned how to tie their instructional activities to state standards. When teachers achieved proficiency with the research-based approach to curriculum, they became Cadre Teachers and assumed leadership roles in their home schools.

The project reported an increase in student critical thinking, research, and decision-making skills.

In addition to the Independence Public Schools and the Truman Presidential Library, partners in WhistleStop included other school districts, Research and Training Associates, Southwestern Bell, South Central Regional Technology in Education Consortium, the Missouri State Department of Education, and Apple Computer, Inc.

State of Utah Resource Web (SURWEB), 1995

Southeast Education Service Center, UT
www.surweb.org

SURWEB gathered an array of 70,000 digitized images, sounds, and movies—each accompanied by explanatory text—for users to select and drag to personal "cyberspace lockers." The "lockers" could be accessed from any location and from any computer platform. Using this remarkable Internet application, teachers and students created visuals to accompany and extend their work in any number of ways, such as multimedia presentations for a research report or a lecture.

The initial vision was for SURWEB to provide virtual field trips of Utah's sights and sounds. In a state of many small towns separated by imposing distances, mountainous terrain, and sometimes severe weather, this idea had considerable merit. SURWEB set out to have students create the online materials, including text (what might be called "captions") for the photographs and other visual images. Experience led staff to reevaluate that idea in favor of having content specialists create the text. Many of the images were provided to SURWEB by parks, museums, and other state educational agencies. Volunteers who simply wanted to share information provided many others.

SURWEB encountered copyright issues related to using images available online. One had to do with ownership of products created by TICG projects: Unless they are copyrighted, these products belong to the public and can be used by anyone as long as proper credit is given to the individual creator and the project. Another issue had to do with whether saving copyrighted images using SURWEB or a similar image storage system (such as WhistleStop) violates copyright law. In the case of SURWEB, the project staff believes the answer is no. Legal advisors have said that because SURWEB slide shows are built instantaneously when a user calls up the show, the slide show does not exist in any permanent form, so does not violate copyright laws.

To give some sense of the size and scope of the project's activities, at the time of writing, SURWEB had 15,000 registered users who had saved more than 14,000 media shows. Navigation tools were designed and located so that even people with limited computer proficiency could succeed. Images were organized into 349 searchable collections, which could be thought of as topics or subjects. Examples of topical collections include Georgia State Historical Photographs, Navajo Baskets, and Yellowstone National Park and Geysers.

Major partners in SURWEB included the state office of education and the Carbon County School District. Advisory board members included the National Park Service, the Utah State Park Service, the Utah State Museum

Services, the Utah State Office of Education, the Utah Education Network, WestEd, and a school superintendent. Membership on the board was stable throughout the project.

As SURWEB expanded beyond the state of Utah, a new organizational structure called iMATRIX was formed to oversee program activities when federal funding ended.

No professional development was designed into the project, but SURWEB hired an "evangelist" to provide workshops around the state to help teachers learn to incorporate the site into instructional activities. During the first two years, the project evangelist trained more than 14,000 teachers, students, and other educators.

SURWEB-using teachers reported success in classroom activities that focused on student-centered, hands-on approaches. Survey results indicated teachers and students were more likely to use the existing SURWEB archive to create media shows than to upload or link original, customized multimedia resources.

SURWEB gathered information about the number of people who visited the Web site, set up their own slide shows, and used the testing and learning segments. Recent data showed about 2.5 million hits per month. The average length of a visit was about 23 minutes, and 50 to 75 media shows were being added to the community area each week. Fifteen other TICG projects received the SURWEB program for their own use. The connections among the projects increased the impact.

A wide array of evaluation data have been collected. A sampling of findings suggests how the accessibility of information through SURWEB related to student performance. When examining these findings, remember that random assignment of students to treatment groups is seldom possible in most school settings.

- Sixth-grade social studies students who created their own media shows did better on performance-based measures of complex knowledge structures and information problem solving.
- A study of sixth-grade users concluded that students' creative thinking, problem-solving skills, and ability to construct complex knowledge structures were enhanced by the use of SURWEB in constructivist, learner-centered classroom environments.
- Students engaged in hypermedia construction scored higher than other students on a norm-referenced measure of creative thinking.
- Seventh-grade social studies students who created their own media shows and who used SURWEB Learning Segments demonstrated significantly higher scores on criterion-referenced, textbook-based tests than did students instructed using traditional methods.

- The same students also showed positive attitudes toward the SURWEB approach.
- Average scores of SURWEB users on criterion-referenced, textbook-based tests were higher than scores of a control group (non-SURWEB users).
- More than 64 percent of elementary and 76 percent of middle school students reported using SURWEB to create media shows.
- Nearly a third (31 percent) of students used SURWEB daily or weekly.
- SURWEB-using students reported more skill in the use of interactive multimedia applications. They were more likely to use SURWEB to create media shows on the Web than to publish their own Web pages with commercial HTML-based software applications.

Other SURWEB evaluation results can be requested from the project. A good test of the value of this resource will occur after the project has been without federal financial support for a while. Will a commercial enterprise see potential in the images collected or in the software developed by the project?

Other Projects: Web Resources

The Community Discovered, 1995
Westside Community Schools District 66, NE
http://communitydisc.wst.esu3.k12.ne.us

The Smithsonian Institution is one of Washington, DC's most popular field trip destinations, but what if you can't get to Washington? What if you can't get to a museum in your state? Community Discovered sought to enhance K-12 education in rural and disadvantaged urban areas by delivering art and art education via technology. The project wanted to support Nebraska art teachers and include art education across all disciplines and grades. The project embraced a constructivist philosophy and designed professional development and instructional activities with this philosophy in mind. The greatest impact was at the elementary level, and the Web site included curriculum units in a searchable database, links to resources, and themed projects for special interest groups, such as cinematography, quilts, pop art, and children's illustrators.

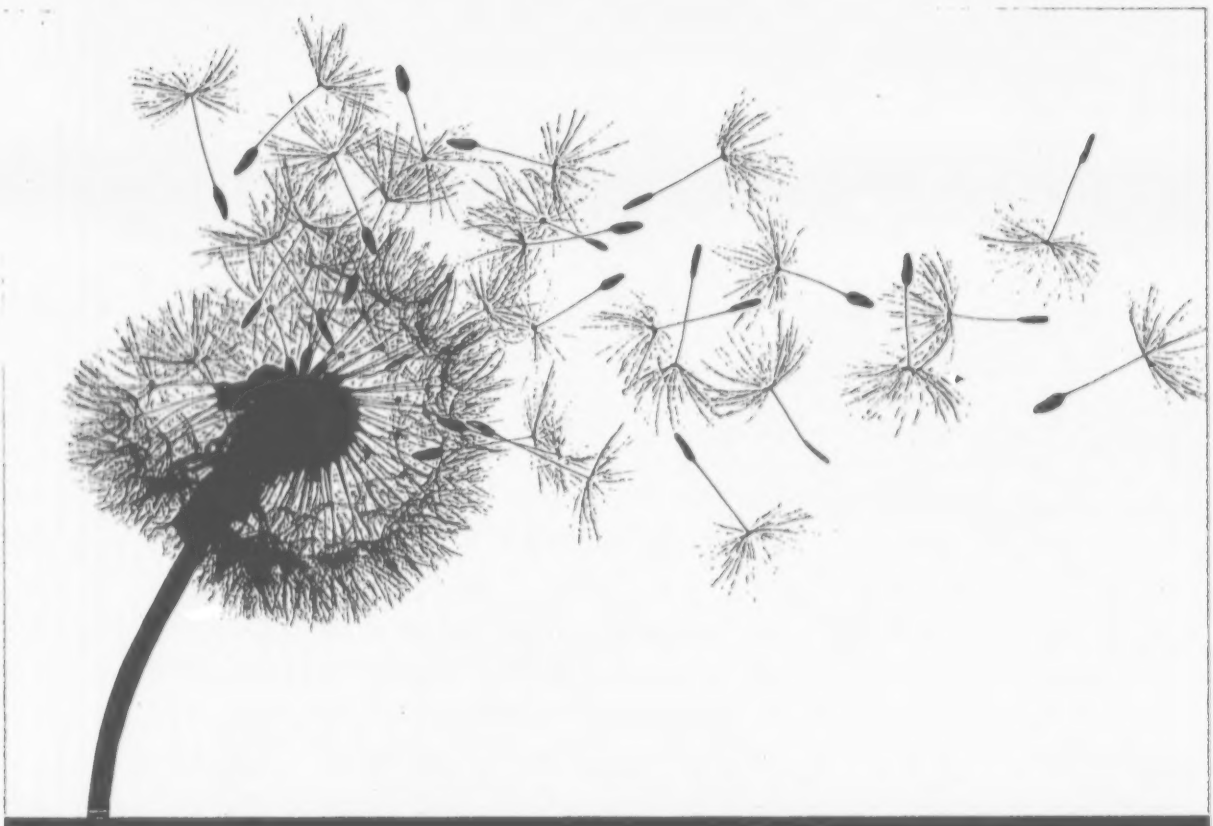
Community Discovered was one of the first projects to tackle the major issues of copyright and system security. Project partners included the Smithsonian, the National Museum of American Art, the Museum of Nebraska Art, the John F. Kennedy Center for the Performing Arts, and the Getty Education Institute for the Arts.

Electronic Learning Marketplace (ELM), 1996
Old Orchard Beach School District, ME
www.elm.maine.edu

The Electronic Learning Marketplace focused on an often-overlooked aspect of instruction—assessment. ELM's major product was a Web-based repository of activities that incorporated technology across all grades and subjects and included detailed descriptions as well as assessments. All activities and assessments were clearly mapped to state standards and peer reviewed to ensure high quality.

Key to this work was training teachers to develop activities and assessments prior to their actual use in classrooms. Teachers who completed the first phase of training, called Take 1, generated more than 125 activities and assessments for the online database. Those who returned for Take 2 completed more detailed records and included examples of student work.

ELM was a collaboration among the Old Orchard Beach Schools, Southern Maine Partnership, and the University of Southern Maine Department of Engineering. The project's widespread impact came from replication of the ELM training model in other districts and the availability of the ELM Web site as a key resource for all K-12 educators—not just teachers in Maine.



PART 3
OBSERVATIONS ON INNOVATION

When we think about how the Technology Innovation Challenge Grant projects might influence uses of education technology, we should keep some things in mind.

First, innovation is relative. An innovative use of technology in school district #1 may not be innovative in school district #2. For example, if teachers try for the first time to keep attendance and grade records on a computer, that is an innovative use of technology *in that school.*

Second, this report examined TICG projects through arbitrary frames that focused on some aspects and downplayed others. Thus the descriptions offered here do not convey the complexity and scope of the projects.

Finally, although this report does not describe projects in great detail, some were examined more closely than others. Information about projects came from the U.S. Department of Education's Office of Educational Technology and the project Web sites. The author did not have the opportunity to visit each project or interview project personnel. The following themes emerged from information about all 62 projects funded from 1995 to 1997, not just the ones with the longest descriptions. Some projects had completed their five-year funding cycles and others had one or two years to go.

To gain a full appreciation for all that Challenge Grant projects can teach us, readers should look more closely at each project.

Themes of TICG Projects

Student Learning

Student Use of Education Technology

- Students used technology most often for gathering information from the Internet and for word processing.
- Technology successfully supported both inquiry-based learning and mastery of subject matter.

Student Achievement

- Some projects found evidence of improved academic achievement, including better scores on standardized and criterion-referenced tests.
- There is mixed evidence about the value of education technology in promoting higher-order thinking skills.
- A focus on raising achievement test scores often conflicted with integrating technology into instruction.

Student Engagement

- Use of technology in the classroom had some positive effects on the self-esteem of children as well as their attitudes toward school.
- Student motivation and interest in learning were often enhanced by use of technology for instruction.
- When teachers integrated technology into project-based instruction, student involvement in collaborative learning activities increased.

Technology Skills

- Computers helped students grow in basic skills. Greater gains were made by students who had access to computers at home.
- Hands-on, interactive learning activities helped prepare students to use technology for work or college.

Content

- There was evidence that each project designed professional development activities to meet local needs and circumstances. No common pattern predominated.
- Curriculum development and professional development went hand-in-hand with the use of technology to support change in how teachers approached their craft.

Strategies

- Effective programs typically grouped teachers by level of proficiency and allowed for progression from gaining personal competence to fully integrating technology into instruction.
- Professional development on the use of technology for instruction was less effective in secondary schools, where resistance to change seemed to be greatest.
- Although no model was clearly superior to others, several were used. Teacher mentoring of colleagues (often with frequent online communication) seemed to be the most common approach.
- No one format or schedule was clearly superior to others, though most employed extensive hands-on learning. Activities were scheduled at different times—summers, weekends, after school, and during school. Some were intensive multiday sessions. Others were held over extended periods. Activities assumed many formats—workshops, demonstrations, online courses, small groups, one-on-one tutoring, and even simulations.

Incentives/Motivation

- Teacher incentives included credit toward a graduate degree, credit for recertification, extra pay for participation, release from regular classroom duty, computers and/or software for classrooms, and technical support.
- Some projects reported that extrinsic motivation was less important to teachers than their desire to become proficient with technology and their satisfaction in seeing student growth.
- Teacher training was usually voluntary but some projects made it mandatory. Mandatory training was usually counterproductive.

Impact on Teaching Practices

- Technology made teaching more exciting and interesting to many teachers.
- Teachers found instruction about uses of technology to be most effective when they had an opportunity to shape and influence the topics they studied and could make immediate hands-on applications.
- Participation in activities devoted to integrating technology into instruction was positively linked to increased collaboration among teachers.
- Proficiency with computers was a prerequisite. Teachers were unlikely to use technology for instruction unless they felt comfortable with their own knowledge of technology.
- Use of technology seemed to be closely tied to changes in teaching style. This was observed in the way teachers approached instruction and even in how they arranged their classrooms to accommodate collaboration among students.
- Concerns about unreliability of equipment and failure of Internet connections seemed to be the biggest deterrents to teacher acceptance and use of computers for instruction.
- Teachers frequently cited lack of time as a major factor that limited their ability to learn about technology and integrate it into their teaching.
- Projects that provided technical assistance for the care and maintenance of equipment reported greater acceptance of technology by teachers.

Parents and Communities

Technology and Parents

- Participation in technology instruction allowed parents to
  - > learn about technology itself
  - > learn how technology is being used in schools
  - > improve their career opportunities
- Parents were more supportive of technology when they were familiar with it from firsthand experience.
- Projects that placed computers in the home or in community agencies increased parent access substantially.
- E-mail made teachers more accessible and more responsive to parents.

Technology and Community

- Connections between schools and the larger community were effective when they were linked to economic development.
- Technology facilitated the connection between school and work.
- The workforce was better educated through the availability of computers in the home and in community agencies.
- Easy access to technology gave parents and community members a greater sense of involvement in the schools.
- There was evidence of greater communication within the community.
- Technology made libraries, museums, and other community resources accessible.

Strengthening Curriculum

- Subject matter was more meaningful to students when it connected to their lives and to the real world.
- Technology provided greater access to valuable source material, much of which was regional in focus, thus providing greater relevance to students and communities while still addressing state or national standards.
- Technology allowed schools to share content. Many projects helped teachers create units and/or lesson plans, which were then posted on Web sites.

Infrastructure

- Local circumstances (such as building age and the availability of cable) were major factors affecting the development of technology infrastructure.
- Technology infrastructure was generally outlined in the project plan, but as projects matured many unanticipated needs emerged.

Connectivity

Distance Education

- Using distance education to pool resources—such as teaching staff for advanced courses—enabled districts and schools to provide

courses and learning experiences they could not provide independently.

- Distance-learning technology did truly allow learning to occur anytime, anyplace.

Learning Communities

- The term "learning community," as it is used in the literature, probably wasn't an accurate description of some projects.[7, 8, 9, 10, 11, 12, 13, 14]
- Homes and community agencies were served best by inexpensive, easy-to-use, and easy-to-maintain computers.

Web Resources

- Some projects disseminated their work effectively on the Internet.
- Networking and information exchanges occurred among many projects—evidence of this can be found on their Web sites.

Leadership and Administration

Project-Level Leadership

- Leadership at the project level was principally the responsibility of the project director, but support from the school district superintendent was critical.
- Success in getting grants and in leading a technology program often opened up new job opportunities for those who were knowledgeable about technology, resulting in turnover in project leadership. Failure to have a backup who had been groomed to assume leadership created serious problems for some projects.

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[7] P. M. Senge. *The Fifth Discipline: The Art and Practice of the Learning Organization* (New York: Doubleday, 1990).

[8] P. M. Senge, A. Kleiner, C. Roberts, R. B. Ross, & B. J. Smith. *The Fifth Discipline Fieldbook: Strategies and Tools for Building a Learning Organization* (New York: Currency Doubleday, 1994).

[9] T. J. Sergiovanni. *Building Community in Schools* (San Francisco: Jossey-Bass, 1994).

[10] T. J. Sergiovanni. Organizations or Communities? Changing the Metaphor Changes the Theory, *Educational Administration Quarterly, 30*(2): 214-26 (1996).

[11] T. J. Sergiovanni. *Leadership for the Schoolhouse* (San Francisco: Jossey-Bass, 1996).

[12] E. L. Boyer. *The Basic School: A Community for Learning* (Princeton, NJ: The Carnegie Foundation for the Advancement of Teaching, 1995).

[13] J. I. Goodlad. *A Place Called School* (New York: McGraw Hill, 1984).

[14] P. C. Schlechty. *Schools for the 21st Century* (San Francisco: Jossey-Bass, 1990).

- Some administrators who were not integral to a project were still supportive in various ways while others created extra hurdles. The main determining factors were how well the administrators understood the project and whether they supported its goals.
- Administrators who helped create a vision for a project were usually more willing to support it than leaders who replaced them. Ownership of the vision was an issue, as was someone coming into an administrative role with a conflicting agenda.
- Successful project directors typically had good political skills and were effective at networking.

School- and District-Level Leadership

- Turnover in leadership positions was nearly always harmful to project success, especially when a superintendent was replaced.
- Many projects worked at helping teachers learn about leadership and helped them assume leadership roles.

State-Level Leadership

- Projects with support from state departments of education improved their chances of success.
- Several project directors and their staffs provided statewide leadership in technology.

Leadership at All Levels

- Leaders were not always administrators, and administrators were not always leaders.
- Leadership roles and their associated skills changed—and changed rapidly. This was due in part to the ever-changing nature of technology.

Evaluation

General Considerations

- A one-size-fits-all approach to evaluation was not appropriate. Project after project reported that more robust evaluation designs were needed, as were better-qualified evaluators who would stay with a project through the five-year cycle.
- Evaluation activities focused on three things: determining whether project goals were being achieved, identifying the need for mid-

course changes, and presenting evidence of the project's overall success.

- Type of analysis undertaken in evaluation activities was closely linked to the stage of technology integration that was occurring in a project.
- Projects described considerable difficulty with gathering student achievement data that could be attributed to technology use.
- Most evaluations focused heavily on qualitative analysis of student work and teacher lesson plans.

Logistics and Personnel

- Evaluators varied in their relationship to the project. Some were actively involved in project activities while others were far removed from the project. Both approaches seemed to work equally well.
- Turnover among project evaluators was common.
- Evaluation plans had to be in place from the outset in order to be effective.

Evaluation Design Considerations

- Evidence of program success did not always relate directly to project goals.
- Most projects involved multiple components that made it difficult to isolate cause-and-effect relationships. Projects that focused on infrastructure addressed the conditions that enabled learning to occur, so it was virtually impossible to tease out main effects.
- Effective evaluation efforts gathered data through quantitative and qualitative methods. These included surveys, interviews, focus groups, self assessments, classroom observations, testing with standardized and teacher-made instruments, journaling, analysis of lesson and unit plans, and case studies.

Standardized Tests as Outcome Measures

- During the project funding periods, states often changed from one standardized test to another and changed the grade levels tested.
- The broad content of national norm-referenced standardized achievement tests seldom aligned well with innovative curriculum activities.

Sustainability

- Projects that were part of larger local and state reform enterprises had better chances of continuing than those that were self-contained. A strong foundation of reform prior to TICG start-up was the greatest contributor to continuation of a project when funding ended.
- Sustainability could not be addressed successfully at the end of a project; it had to emerge as an issue early in the life of a project.
- Success begat success in sustaining a project beyond TICG funding.
- Projects with strong support from state departments of education improved their chances of sustaining themselves or at least institutionalizing their ideals.
- Partners who had a stake in a project were helpful in sustaining activities beyond federal funding.
- Cost-cutting measures enabled some projects to sustain themselves. These included narrowing the scope and reducing the number of goals. A few projects turned products into moneymakers that contributed to sustaining some activities.
- Sustainability was adversely affected by high rates of turnover in teaching and administrative staff. Project effects tended to diminish when people departed.

Scaling Up

- Several projects achieved impact well beyond their initial targets. Some had impact statewide and several had national impact.
- Ideas that worked well did not always move easily to other locations. Local and state contexts had as much to do with whether ideas had application elsewhere as did the nature of the ideas themselves.
- Projects often focused on immediate, local needs. Successful scaling-up efforts required consideration from the outset. Many schools lacked the knowledge and experience to scale up their ideas and products. Often, efforts to scale up came too late to have widespread impact.

Dissemination

- Most projects had active Web sites that provided extensive information, including full evaluation reports with data and data collection instruments.
- Expectations for dissemination, particularly among projects that achieved high profiles early in their cycles, sometimes resulted in activities being shared before they were adequately evaluated.

Partnerships

Conditions that Encouraged Successful Partnerships

- Effective partnerships involved shared goals and objectives while also giving each partner a way to satisfy individual aspirations. Clear expectations from the outset were important.
- Partnerships worked best when each partner's chief executive officer was committed to the arrangement.
- Partners needed "care and feeding" to remain engaged in a project. Communication that kept all apprised of project activities was usually the key.
- Partners varied in the degree and timing of their involvement. Some participated little and others participated extensively. Some participated early and briefly while others participated throughout a project.
- Successful partnerships provided for the graceful exit of partners whose goals had been accomplished.

Characteristics of Effective Partnerships

- All partners had reasons for participating. Motives such as making a profit were not necessarily harmful if they contributed to a project reaching its goals.
- When partners entered a project late, it was usually because a special need emerged that they could help address.
- Partners that provided more than just services or products were successful. Comprehending the intricacies of classrooms or understanding the desired outcomes for students were important in developing successful partnerships.

- Solutions to specific problems or concerns with integrating technology into instruction had to be understood in the broader context of schooling.
- Projects existed in the context of politics and reform efforts at the local and state levels. Conflict or synergy occurred depending on how well the project fit the context and how well it aligned with ongoing activities.
- Continuation of a project beyond TICG funding often depended on whether there was a good fit with the larger, continuing agenda.
- Projects that had allies in key positions had a much greater chance of success. This kind of relationship seldom happened by accident; it was built deliberately.

Summary Observations

The least surprising discovery of the Technology Innovation Challenge Grant program is that no "smoking gun" evidence establishes education technology as the key to school improvement. TICG projects have made many positive differences in the localities where they were implemented. The descriptions in this report make that clear, and the project Web sites confirm that impression. Interesting and exciting things happen when educators effectively integrate technology into instruction. This trend will continue, as it should. However, we need to understand that nothing as complex as the impact of technology on education can be fully explained or proven. No regression analysis can demonstrate that access to computers accounts for a certain change in student performance. There are simply too many variables and too many possibilities.

Of course, schools must not ignore how important technology has become to the fabric of our society. We hardly need noteworthy gains on achievement tests to conclude that schools must accommodate computers, scanners, digital cameras, and the Internet. That leads logically to the question "Is it necessary or important to measure the impact of education technology on children and schools?" Perhaps the question we should be asking is "What can we do to ensure that we get value from education technology?"

The experiences of the Technology Innovation Challenge Grant projects seem to point to three key considerations: (1) evaluation, (2) time, and (3) context.

Evaluation

There can be no doubt that new ideas must receive close evaluation during implementation. TICG supported and encouraged such evaluation from its outset. Federal guidelines increased recommendations for evaluation from 5 percent of a project's budget to 15 percent. This important development could set a useful precedent for other educational programs.

Projects must be helped in deciding what kinds of information they should gather and encouraged to gather data over a period of time that is long enough for program effects to ripen. Some results, perhaps those most relevant to program goals, will not appear overnight. For example, it will take many years to learn whether school-to-work connections have any significant effect on children's career plans or work performance.

One reason for increasing evaluation funding was that projects experienced enormous difficulty with the complex and demanding issues encountered in designing and carrying out adequate evaluations. In addition, the Government Performance and Results Act of 1993 compounded the situation by layering on new and different expectations for data gathering after many projects were up and running.

Clearly there are lessons to be learned from the evaluation activities of TICG projects. Chief among them is that project evaluation must be multifaceted and long term. Informal as well as formal data collection activities are appropriate, particularly when the standardized test results do not relate directly to project goals.

Time

TICG shows the importance of giving projects time to develop and mature. Initially they need time to develop a sense of community and to deal with the inevitable start-up problems. Later, time makes it possible to refine and expand the enterprise. The five-year window of opportunity created by TICG funding permitted projects to work through these developmental stages and to make the most of formative evaluation. Projects could collect the data needed to make midcourse corrections and to study the effects of such changes. This could only have happened with long-term funding. The goals of adopting practices systemwide and sustaining them beyond the end of federal funding had a chance to succeed because time was provided to explore, make changes, and perhaps even to fail.

Context

When a specific issue, such as technology, gets separated from the broader context of schooling, steps may be taken to address one concern without considering sufficiently how that action will impact other concerns or the total system. For example, when news stories tell about students who do not have access to computers, the obvious solution is to get some computers. However, such judgments should be made in the context of the school. Will the building's electrical wiring handle the increased load? Can the computers be linked to the Internet? Do the teachers know how to use the computers for instruction? Will time spent on learning to use computers reduce or eliminate time spent on other topics and concerns—learning to read or working collaboratively with others, for example? Will money needed to upgrade and update the computers take away from other needs? Of course, computers can be used to help achieve other goals. It need not be an either/or dilemma, but too often that is exactly what happens.

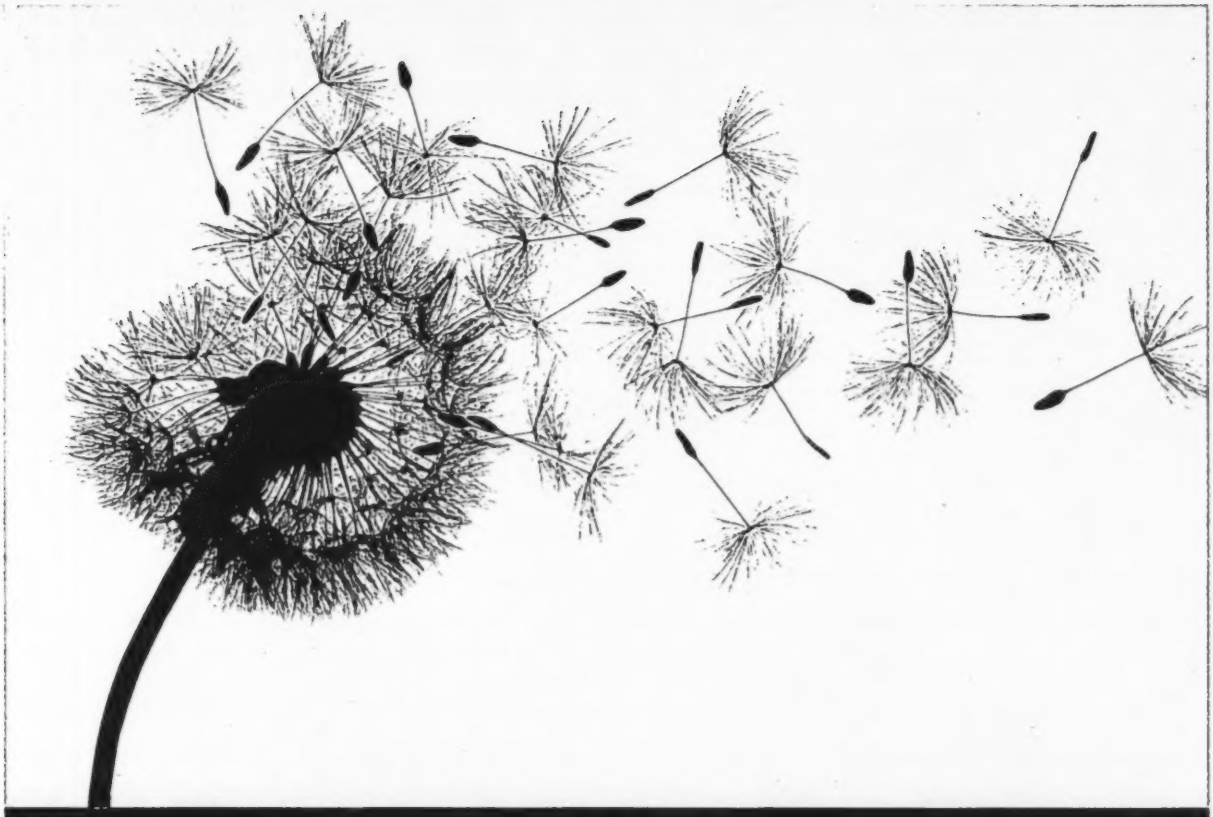
In recent years accountability has been added to the challenges schools confront, and the challenge of creating a rational and workable accountability system has proved to be daunting. The standards movement has given rise to debate about other issues, such as what knowledge children must learn by a certain grade level and how mastery should be assessed. At the state level, high-stakes testing programs often hold students, teachers, and schools accountable for performance. Technology may or may not be an integral part of such testing programs.

For the most part, however, computers and technology are not essential for improving student performance on the kinds of learning that high-stakes tests measure. This contradiction is one that confuses and frustrates teachers and administrators on a daily basis.

Embedded in the challenge of helping teachers learn to use technology for instructional purposes is the endemic challenge schools face in helping teachers develop as true professionals—acting as decision makers who continue to learn and grow so that remaining in the profession is attractive. This challenge is particularly important at a time when the need for additional teachers and administrators is acute, especially in certain disciplines—math, science, special education, and instructional technology—and in certain locations—inner cities and remote rural areas.

Schools also face the daunting challenge of developing effective ways to integrate the school into the community, working effectively in partnership with parents and other community "structures" such as businesses and social agencies, including faith-based organizations. Some TICG projects addressed this aspect of technology use in a direct and explicit fashion, but the results were uneven, at best.

Technology certainly belongs in schools, but it alone cannot "fix" schools. Reformers, whether they be teachers, parents, administrators, lawmakers, business executives, members of the clergy, philanthropists, or students themselves, should take an educational Hippocratic Oath, pledging that they will, "First, help children learn."



APPENDIX A
TECHNOLOGY INNOVATION CHALLENGE GRANT PROJECTS: 1995, 1996, 1997

Technology Innovation Challenge Grant Projects: 1995, 1996, 1997

CALIFORNIA

Triton Project (1995)
San Diego Unified School District
Contact: **Michael Casey**
Educational Technology Department
2470 Ulrich Street, Room 305
San Diego, CA 92111
858-573-5793
858-573-5799 fax
mike@edtech.sandi.net
URL: http://projects.edtech.sandi.net
Allen Bersin, Superintendent

Marcie J. Bober, Evaluator
San Diego State University
Dept. of Educational Technology
5500 Campanile Drive
San Diego, CA 92182-1182
619-594-0587
619-594-6376 fax
marcie.bober@sdsu.edu

Silicon Valley Challenge 2000 Multimedia Project (PBL+MM) (1995)
San Mateo County Office of Education
Contact: **Joe Becerra**
101 Twin Dolphin Drive
Redwood City, CA 94065
650-802-5445
650-802-5521 fax
jbecerra@smcoe.k12.ca.us
URL: http://pblmm.k12.ca.us
Floyd Gonella, Superintendent

Barbara Means, Evaluator
SRI International
333 Ravenswood Avenue
Menlo Park, CA 94025-3493
650-859-4004
650-859-4605 fax
barbara.means@sri.com

Advanced Curriculum Through Technology (A.C.T. Now!) (1996)
Sweetwater Union High School District
Contact: **James Frazee**
1130 5th Avenue
Chula Vista, CA 91911
619-691-5780
619-585-8817 fax
james.frazee@suhsd.k12.ca.us
URL: www.suhsd.k12.ca.us/actnow
Dr. Edward Brand, Superintendent

Marcie Bober, Evaluator
6673 Vigo Drive
Le Mesa, CA 91941
619-667-9384
619-667-9385 fax
bober@mail.sdsu.edu

Teacher Led Technology Challenge (TLTC) (1996)
Berkeley Unified School District
Contact: **Janet Levenson**
1720 Oregon Street
Berkeley, CA 94703
510-644-6490
510-644-7738
janet_levenson@berkeley.k12.ca.us
URL: http://tltc.berkeley.k12.ca.us
Michele Barraza Lawrence, Superintendent

Linda Toms-Barker, Evaluator
Berkeley Planning Associates
440 Grand Avenue, Suite 500
Oakland, CA 94610
510-465-7884
510-465-7885 fax

PASS Internet Program: Cyber High (1997)
Fresno County Schools
Contact: **Guido Prambs**
823 West Nielson Avenue
Fresno, CA 93720
599-488-7545
599-264-8326 fax
gprambs@scoe.k12.ca.us
URL: www.cyberhigh.fcoe.k12.ca.us
Dr. Peter G. Mehas, Superintendent

Dr. Howard Wolff, Evaluator
1966 Honey Run Road
Chico, CA 95928
530-896-1715
530-896-1027 fax
bcra@sunset.net

CALIFORNIA (cont'd)

Project LemonLINK: The Connected Learning Community (1997)
Lemon Grove School District
8025 Lincoln Street
Lemon Grove, CA 91945
Contact: **Barbara Allen**
619-825-5600
619-589-5737 fax
ballen@lgsd.k12.ca.us

Darryl LaGace
619-825-5600
619-589-5737 fax
dlagace@lgsd.k12.ca.us
URL: www.lgsd.k12.ca.us/lemonlink
Lean King, Superintendent

Dr. Therese Snyder, Evaluator
8025 Lincoln Street
Lemon Grove, CA 91945
619-589-5600
619-462-7959 fax
tsnyder@lgcd.k12.ca.us

The New Spectrum Learning Program (NSLP) (1997)
Los Angeles Unified School District
Contact: **Deborah Brooks**
2445 Daly Street, Room B002
Los Angeles, CA 90031
323-224-6191
323-244-6199 fax
djbrooks@workforcela.org
URL: www.workforcela.org/nslp.htm
Roy Romer, Superintendent

Mary-Ann Pomerleau, Ed.D., Director, Evaluator
Performance Learning, L.L.C.
902 Franklin Street
Santa Monica, CA 90403-2320
310-828-1260
310-453-3666 fax
mapomerleau@earthlink.net

Technology in Nature in Sanger (TINS) (1997)
Sanger Unified School District
Contact: **Mr. Kim Jacobsen**
1905 7th Street
Sanger, CA 93657
559-875-5182
559-875-1302 fax
kim_jacobsen@sanger.k12.ca.us
URL: http://tins.sanger.k12.ca.us
Marcus Johnson, Associate Superintendent

Drs. John and Ruthmary Cradler, Evaluators
Education Support Systems
406 Glendale Road
San Mateo, CA 94402
650-344-7046
415-344-3604 fax
cradler@earthlink.com

DELAWARE

Delaware Interactive Educational Television Consortium (1995)
Capital School District
Contact: **Dr. Tina Huff**
945 Forest Street
Dover, DE 19904
302-672-1951
302-672-1727 fax
Thuff@Capital.k12.de.us
URL: www.challenge.k12.de.us
Dr. James Hammond, Superintendent

Pam Brown, Evaluator
University of Delaware
305 Willard Hall
Newark, DE 79716
302-831-4434
pjbrown@udel.edu

FLORIDA

Career Connection to Teaching with Technology (CCTT) (1997)
Volusia County School Board
Contact: **Marshall R. Ransom**
Mainland High School
125 South Clyde Morris Boulevard
Daytona Beach, FL 32114
386-226-0355
386-226-0332 fax
mransom@mail.volusia.k12.fl.us
URL: www.cctt.org
William E. Hall, Superintendent

Karen Cohen & Associates, Evaluator
9 Cliff Road
Weston, MA 02493
781-237-3351
781-237-0567 fax
cohenka@aol.com

GEORGIA

Education for a Sustainable Future (ESF) (1997)
Cobb County School District
Contact: **Sue Brown**
514 Glover Street
Marietta, GA 30060
770-429-5840
770-429-5839 fax
suebrown@cobbk12.org
URL: http://csf.concord.org/esf
Joseph Redden, Superintendent

Karen Cohen & Associates, Evaluator
9 Cliff Road
Weston, MA 02193
781-237-3351
781-237-0567 fax
cohenka@aol.com

HAWAII

The Electronic School (1996)
Hawaii State Department of Education
Contact: **Vicki Kajioka**
1390 Miller Street, Room 314
Honolulu, HI 96813
808-586-3349
808-586-3645 fax
Vicki_Kajioka@notes.k12.hi.us
URL: www.eschool.k12.hi.us
Patricia Hamamoto, Interim State Superintendent

Drs. John & Ruthmary Cradler, Evaluators
Education Support Systems
406 Glendale Road
San Mateo, CA 94402
650-344-7046
650-344-3604 fax
cradler@earthlink.net

IDAHO

Just in Time (1997)
Blackfoot School District #55
Contact: **Helen "Betsy" Goeltz**
270 East Bridge
Blackfoot, ID 83221
208-782-9548
208-785-2042 fax
goelb@g55.k12.id.us
URL: http://challenge.isu.edu
Dewane Wren, Superintendent

Ruthmary Cradler, Evaluator
Eduucation Support Systems
406 Glendale Road
San Mateo, CA 94402
650-344-7046
650-344-3604 fax
cradler@earthlink.net

ILLINOIS

Technology and Learning Collaborative (TLC) (1995)
Waukegan Community Unit School District 60
Contact: **Elaine Armani**
1201 North Sheridan Road
Waukegan, IL 60085
847-360-5440
847-360-5628 fax
Armani@mail.wps.lake.12.il.us
URL: www.ed.gov/Technology/Challenge/ProjectDesc/pt6.html
Bob Kirtz, Superintendent

Dr. Gilbert Valdez, Evaluator
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Oak Brook, IL 60523-1480
630-571-4700
630-571-4716 fax
valdez@ncrel.org

ILLINOIS (cont'd)

Reality Based Learning Project (RBL) (1996)
Kirby School District #140
Contact: **Dr. Edward O. Shaffer**
Administrative Center, Box 98
Tinley Park, IL 60477
708-532-6462
708-802-9560 fax
hdannenberg@140.s-cook.k12.il.us
URL: www.d348.wabash.k12.il.us/rbl/main.htm
Arnold L. Drozonek, Superintendent

Tisha Pryor, Evaluator
Education Development Center
Center for Children in Technology
96 Morton Street, 7th Floor
New York, NY 10014
212-807-4241
212-633-8804 fax

Learning Community 2000 (1996)
Pekin Public School District #108
Contact: **Chuck Bowen**
501 Washington Street
Pekin, IL 61554-4239
309-477-4740
309-477-4701 fax
cbowen@pekin.net
URL: www.pekin.net/pekin108/lc2000
Perry Sowldwedel, Superintendent

Dr. Karen Fernoding, Evaluator
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Department of Curriculum & Instruction
315 Education Building, MC/798
1310 S. 6th Street
Champaign, IL 61820-6990
217-244-5556
217-356-9780
fernedin@uiuc.edu

Chicago Neighborhood Learning Network (CNLN) (1997)
Chicago Public Schools
Contact: **Ila Weinberg**
125 S. Clark Street, 5th Floor
Chicago, IL 60603
773-553-1428
773-553-1402 fax
lweinberg@csc.cps.k12.il.us
URL: www.edc.org/ewit/cnln
Paul Vallas, Superintendent

Dr. John Wong, Evaluator
Education Development Center
55 Chapel Street
Newton, MA 02158
617-618-2348
617-332-4318 fax
jwong@edc.org

INDIANA

Anderson Community Technology Now (A.C.T. Now!) Project (1995)
Anderson Community School Corporation
Contact: **David Wood**
30 West 11th Street
Anderson, IN 46016
765-641-2151
765-641-2081 fax
URL: www.acsc.net/~actnow
Dr. Tim Long, Superintendent

Dr. Jerrell Cassady, Evaluator
Ball State University
Department of Educational Psychology
TC 520
Muncie, IN 47306
765-285-8500
jccassady@bsu.edu

The Learning Cooperative (1995)
Indianapolis Public Schools
Contact: **John Kern**
801 North Carrollton Avenue
Indianapolis, IN 46202
317-226-4152
317-226-3130 fax
kern@ips.k12.in.us
URL: www.thelearningcooperative.net
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Students as Agents of Change (1996)
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Kansas Collaborative Research Network (KanCRN) (1997)
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Electronic Learning Marketplace (ELM) (1996)
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Baltimore Learning Community (BLC) (1995)
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The Virtual High School (1996)
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MetroLINC (1997)
Boston Public Schools
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Teaching and Learning with Technology:
Bridging Schools & Home with Technology (1996)
Lawrence Public Schools
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The Trails Project (1996)
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The Community Discovered (1995)
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The Connections Project (1996)
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The Corning Community Project for Learning and Teaching (1996)
Corning City School District
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America Gateways: Immigration and Migration in the United States (1996)
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ABC Technology in Education Partnership (1997)
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NatureShift! Linking Learning to Life (1997)
Grand Forks Public School District #1
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New Technology, New Knowledge, New Work (New 3) (1995)
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Aurora Project (1997)
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Philadelphia Technology Consortium (1995)
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New Vision (1995)
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Greene County Technology Initiative (1996)
Greene County Vocational-Technical School
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Extending Learning Through Community and Family (1997)
Sumter County School District Two
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Visions TECWEB (1997)
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WEB Project: Creating a Web of Evidence of Student Performance (1995)
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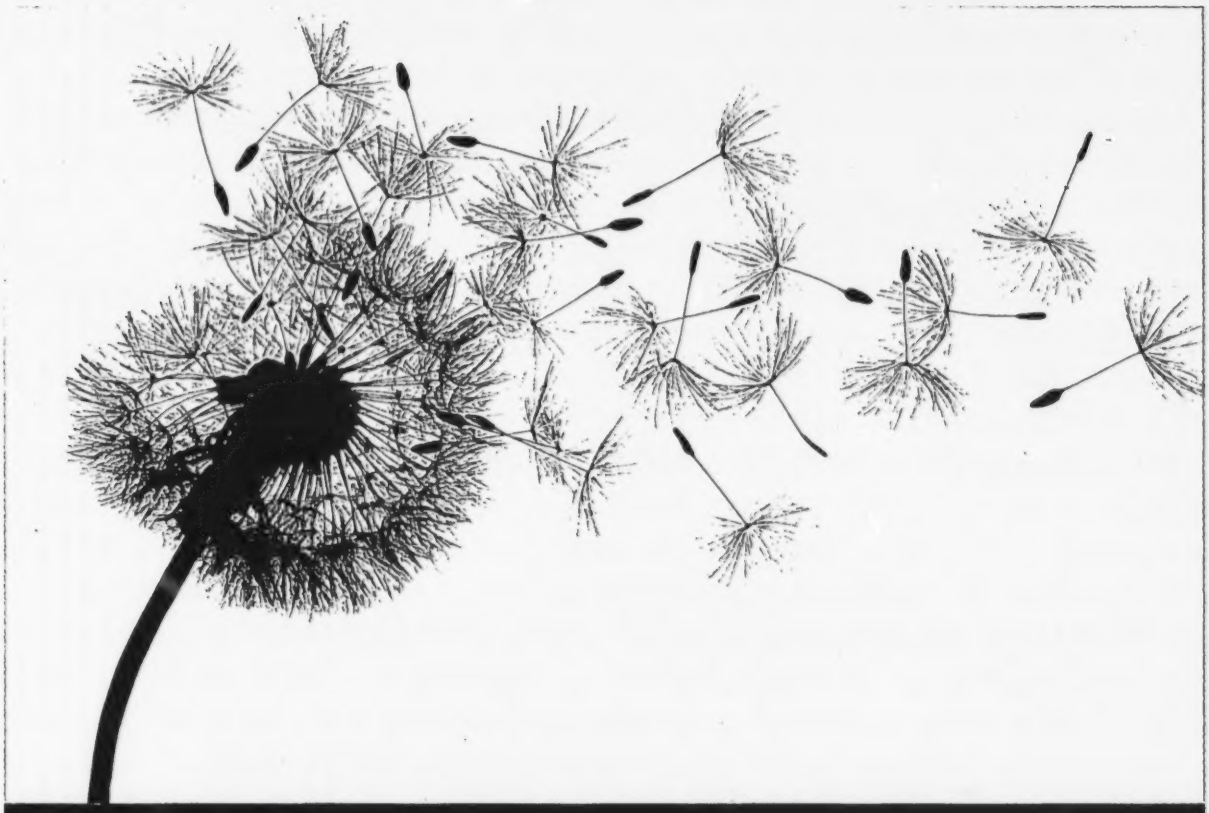

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